POWER

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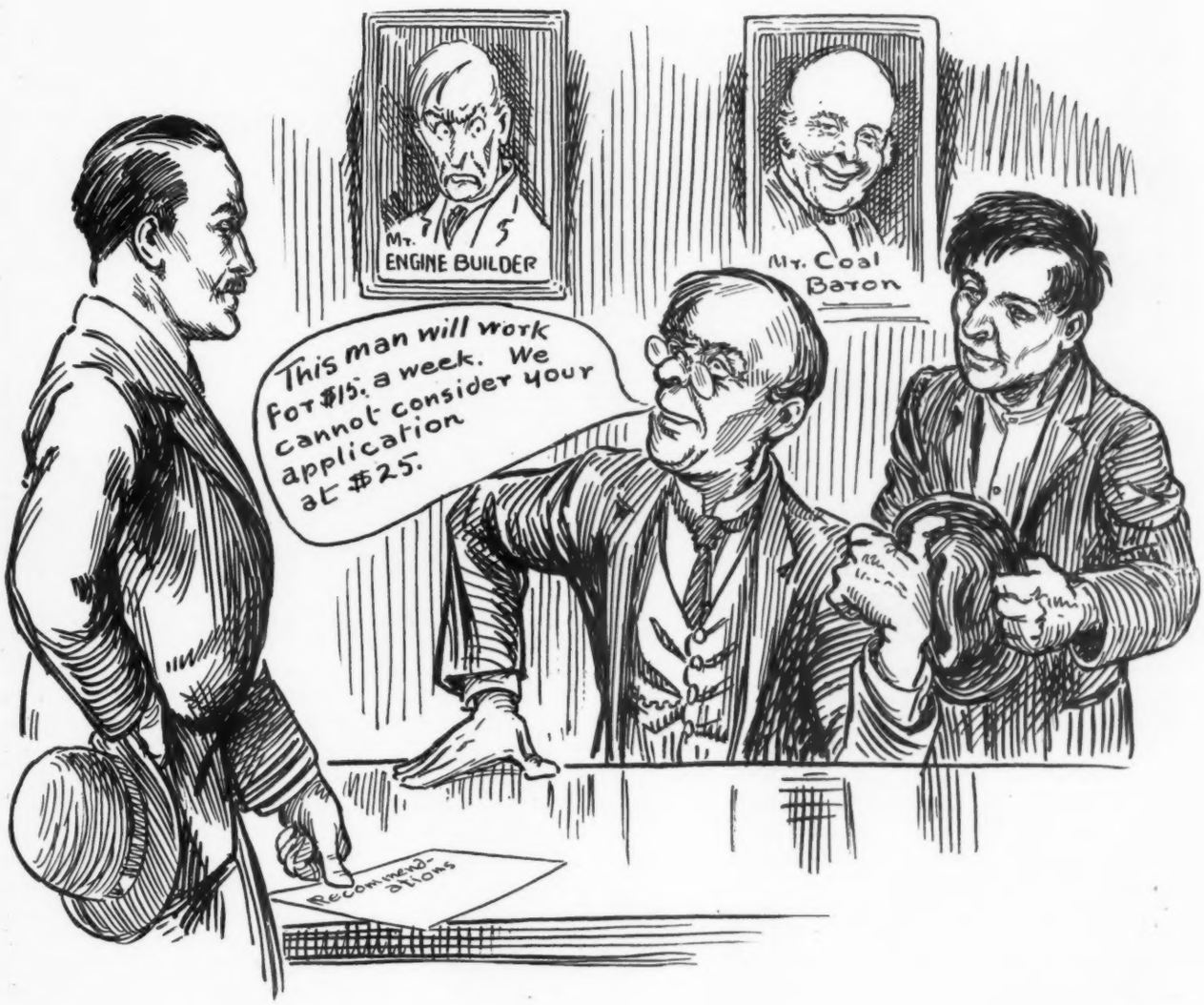
Why Educate the Engineer While the Employer Remains Ignorant?


Mr. ENGINE BUILDER
Mr. Coal Baron
This man will work for $15. a week. We cannot consider your application at $25.
Recommendations

Ten plunks saved? 'Tis indeed a question whether employer or employee needs most the education.

(*With apologies to Shakespeare.*)—[*Suggested by R. O. Richards, Framingham, Mass.*]

Power Plant of the Granby Co.

By Thomas Wilson

SYNOPSIS—An 800-kw. plant furnishing light, heat and power for the immense new smelting and acid works of the Granby Mining & Smelting Co. in East St. Louis. In such a works reliability of service is of great importance, and this was made the primary factor in the design of the power plant. Marine-type settings for the boilers, a special purifier and heater and a complete oiling system are the features.

About two years ago the Granby Mining & Smelting Co. built an immense smelter at Rose Lake, in East St. Louis, Ill. The plant was designed for the manufacture of spelter and acid and is one of the most uptodate and substantial of its kind in the country. In the various processes of manufacture large quantities of steam will be required. Producer gas is to be used for smelting and calcining, and in the making of acid there will be large demand for water. The pumps and various other machines around the works are electrically driven, and current will be furnished from a central power plant. Direct and indirect heating for the various buildings, pottery rooms, etc., and the feedwater heater will take all of the exhaust steam, summer and winter. It is the intention to start manufacturing at an early date, and even now the power plant is running under a light load created by the preparations under way.

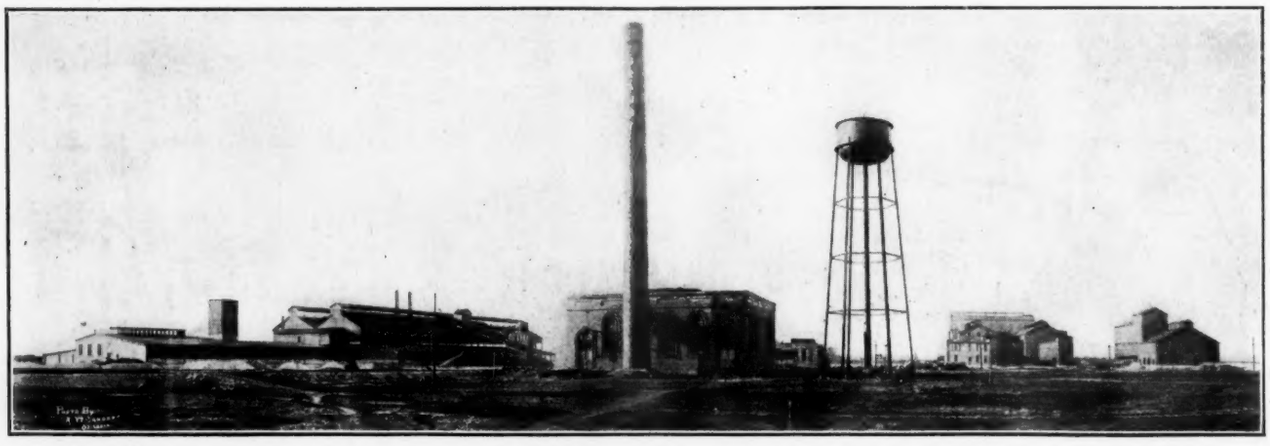


Fig. 1. Panoramic View of the Granby Smelter

A general view of the works is shown in Fig. 1. The power plant appears at the center of the picture. It is a strictly fireproof brick building separated into engine and boiler rooms by a division wall. The interior plan dimensions are 89x98 ft. and the height from the floor to the roof trusses, 31 ft. The structure rests on massive concrete foundations designed to bear only two tons per square foot, owing to the presence of quicksand. Careful design of the building and arrangement of the equipment have resulted in an attractive plant. That the comforts of the employees have not been forgotten is made evident by the provision of shower baths, wash and locker rooms, toilets, and the like.

In the boiler room, shown in Fig. 2, the equipment consists of 1050 hp. in boilers divided into three 350-hp. units of the horizontal water-tube type. The settings are of the marine type, consisting of fire-brick, 3-in. asbestos blocks and a steel-plate covering. Steam at 150-lb. pressure is supplied to 800 kw. in generating capacity, an air compressor and the feed pumps. Besides, some live steam will be required in the manufacturing processes. The uses for steam outside of generating electricity and the installation of a spare boiler, account for the excess of boiler over generating capacity. The actual ratio is 1050 to 800, or 1.3 boiler horsepower per kilowatt.

Chain-grate stokers having an area of 70 sq.ft. serve the boilers. When compared to the 3500 sq.ft. of heating surface the ratio is standard at 50 to 1. The boilers are vertically baffled for three passes, and between the furnace and the first pass a restricted throat insures the thorough mixture of the gases so necessary for smokeless operation. A steel-plate breeching, thoroughly covered, carries the gases in a straight line to the stack. The width throughout is 6 ft. 6 in., and the height increases from 3 ft. 3 in. at the third boiler to 10 ft. The gases, then, discharge through an area of 65 sq.ft. into a special tile and concrete stack lined throughout with firebrick. The stack rises 185 ft. above the grates, the diameter is 8 ft. and the sectional area of the bore is a trifle over 50 sq.ft. The ratio of stack to breeching area is thus 10 to 13, or 1 to 1.3. For every square foot of connected grate surface, there is 0.31 sq.ft. of breeching and 0.24 sq.ft. of stack. Per 1000 sq.ft. of boiler-heating surface the areas of breeching and stack are 6.2 and 4.7 sq.ft., respectively.

A stack draft of 1.1 in. with a gas temperature of 500 deg. reduces to 0.8 in. at the breeching side of the damper on the boiler farthest from the stack. A drop of 45 to 50 per cent. through the damper and boiler setting gives a draft of approximately 0.4 in. over the fire.

Coal is brought in over one of the several sidings entering the property and is transferred from the railway cars by a 10-ton locomotive crane, to a 200-ton open concrete bunker, running along the west wall of the boiler room. Through gates the coal gravitates into the boiler room

and is shoveled into the hoppers of the stokers. Originally, it was the intention to install complete coal-handling equipment and this may be done when the plant is put under full operation.

From the pits under the stokers the ashes are raked into industrial cars. A 6-ton kerosene locomotive pulls the cars, and the ashes may be dumped in any part of the yard where filling is required.

Treating Boiler-Feed Water

Water for boiler feeding is taken from wells on the premises. As the following analysis will show, it proved to be high in scale-forming matter, and it was decided to install a hot-process system for treating it chemically before passing it along to the boilers.

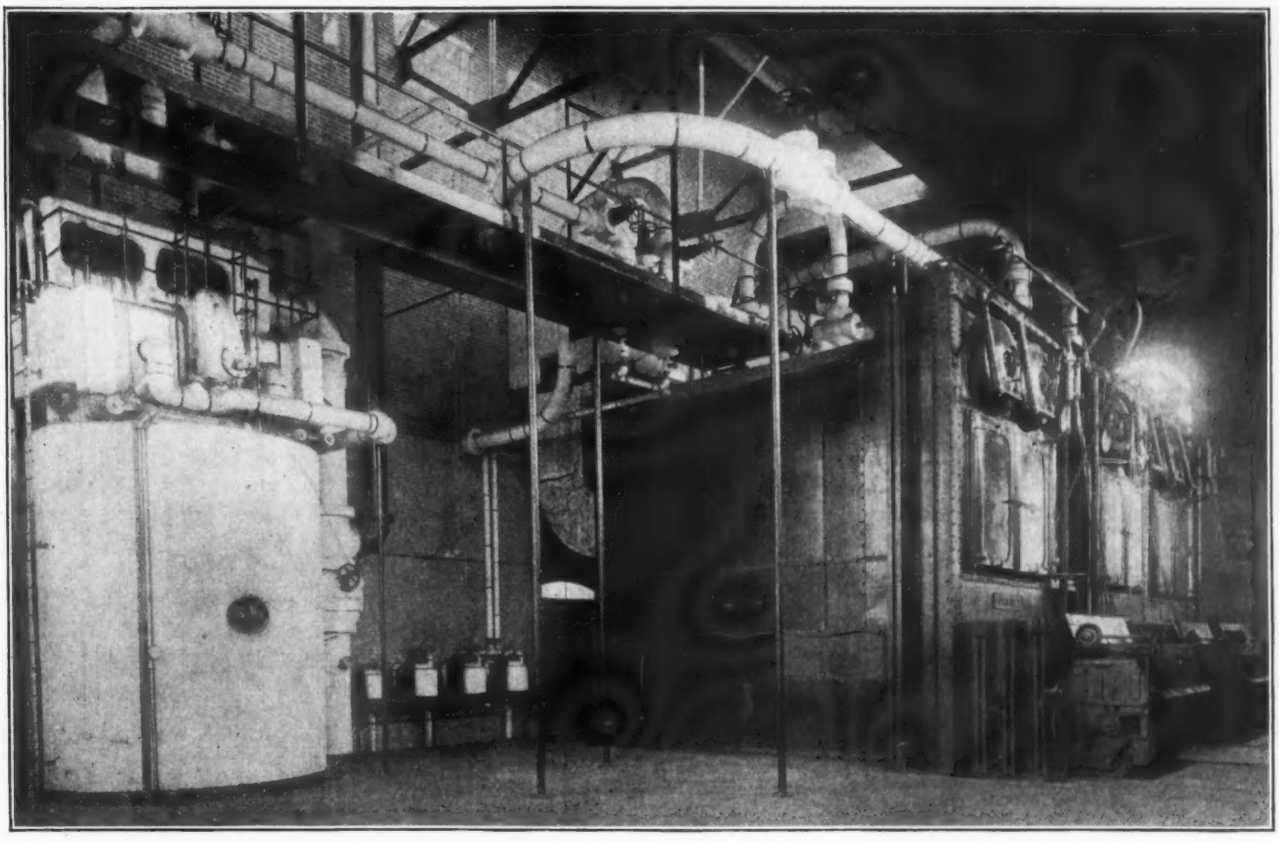


Fig. 2. The Boilers and Combination Purifier and Heater

ANALYSIS OF WELL WATER

Chemical Impurities	Grains per U.S. Gal.
Suspended matter	1.00
Organic and volatile	2.12
Silica	1.75
Calcium carbonate	13.75
Magnesium carbonate	4.04
Magnesium sulfate	0.88
Sodium sulfate	0.35
Sodium chloride	0.29
Total solids	24.18

The apparatus in use at this plant is of the vertical type shown in Fig. 7. While the various parts going to make up the complete outfit are more or less standard, their arrangement and the combinations employed differ for each plant, so that a description of the present system may be of interest. The raw water from the service supply enters the heating section, shown at the top, through a balanced regulating valve operated by a float in the float box, which maintains a uniform level in the storage chambers above the filters. Within the heating chamber are trays for breaking the water up into a fine shower in order that the exhaust steam which enters through the separator attached to the heating chamber may heat the water to a point at or near boiling. The hot water then falls by gravity into the treating and sedimentation chamber, striking at the top a baffle which tends to distribute it uniformly and at the same time mix it with the reacting chemical which is fed into the raw water as it passes from the heating chamber to the treating and settling tank. This tank is made large enough to give the chemical time to act and the precipitation to settle to the bottom, where it can be drawn out through a sludge valve and discharged to any convenient point.

During this period the water passes down the outside and up the inside of the cone shown in the tank. At the top it is distributed between the two filter chambers set above the treating tank. In these are provided suitable supporting gratings carrying a wood-wool filter bed held in place by grids. The water from the treating tank may contain floating impurities that will not settle. These are caught by the filter and pure water passes up into the storage compartment above, where it is available for boiler purposes.

The filters are arranged in duplicate and so connected that one or both may be cut out of service for cleaning, at the same time leaving the heating section and the treating and sedimentation tank in service.

The amount of chemical to feed is determined by test, a simple equipment for the purpose having been provided. The proper proportion is then fed automatically into the system, which has a capacity to heat and treat 5420 gal. of water per hour.

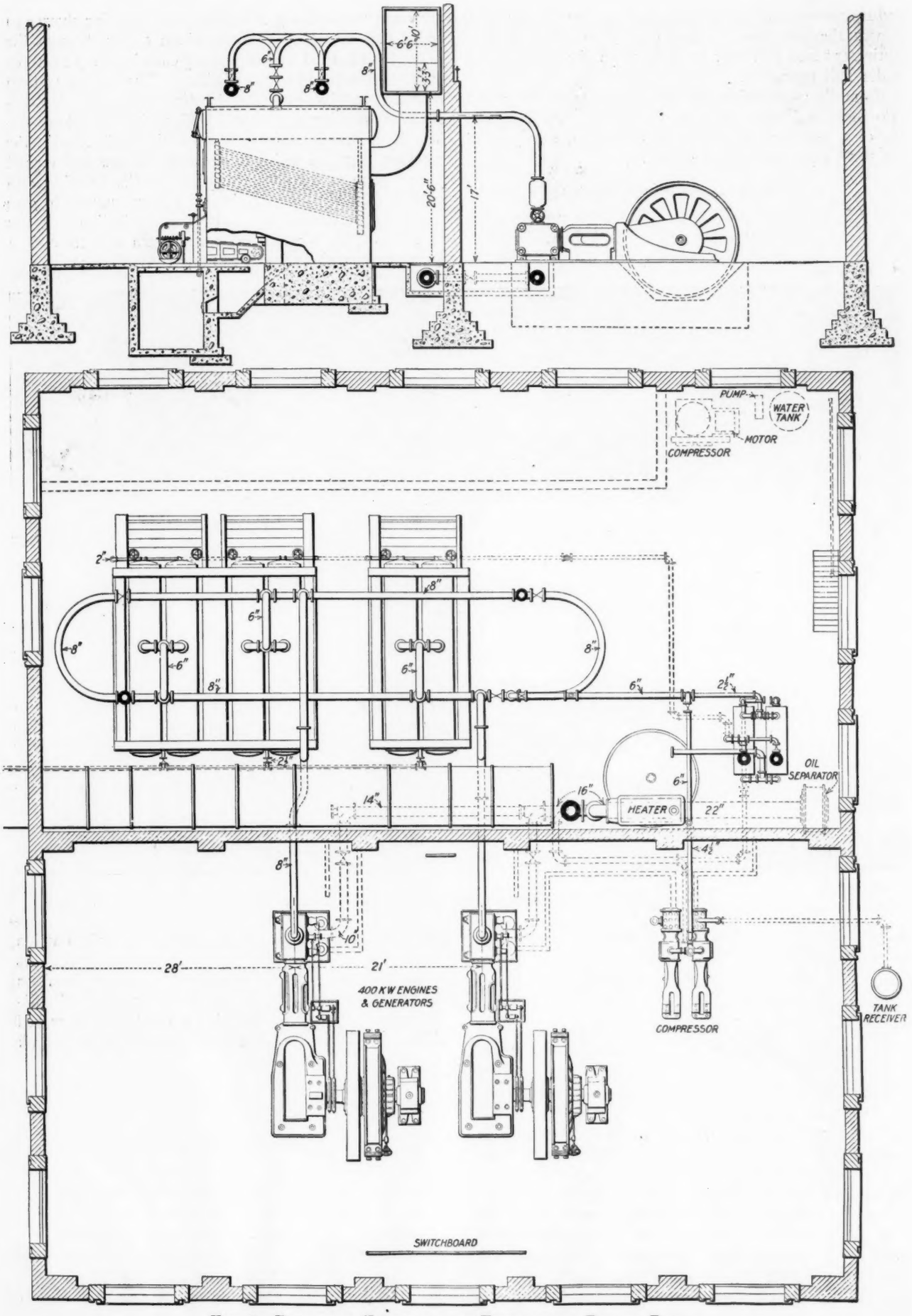


FIG. 3. PLAN AND ELEVATION OF ENGINE AND BOILER ROOMS

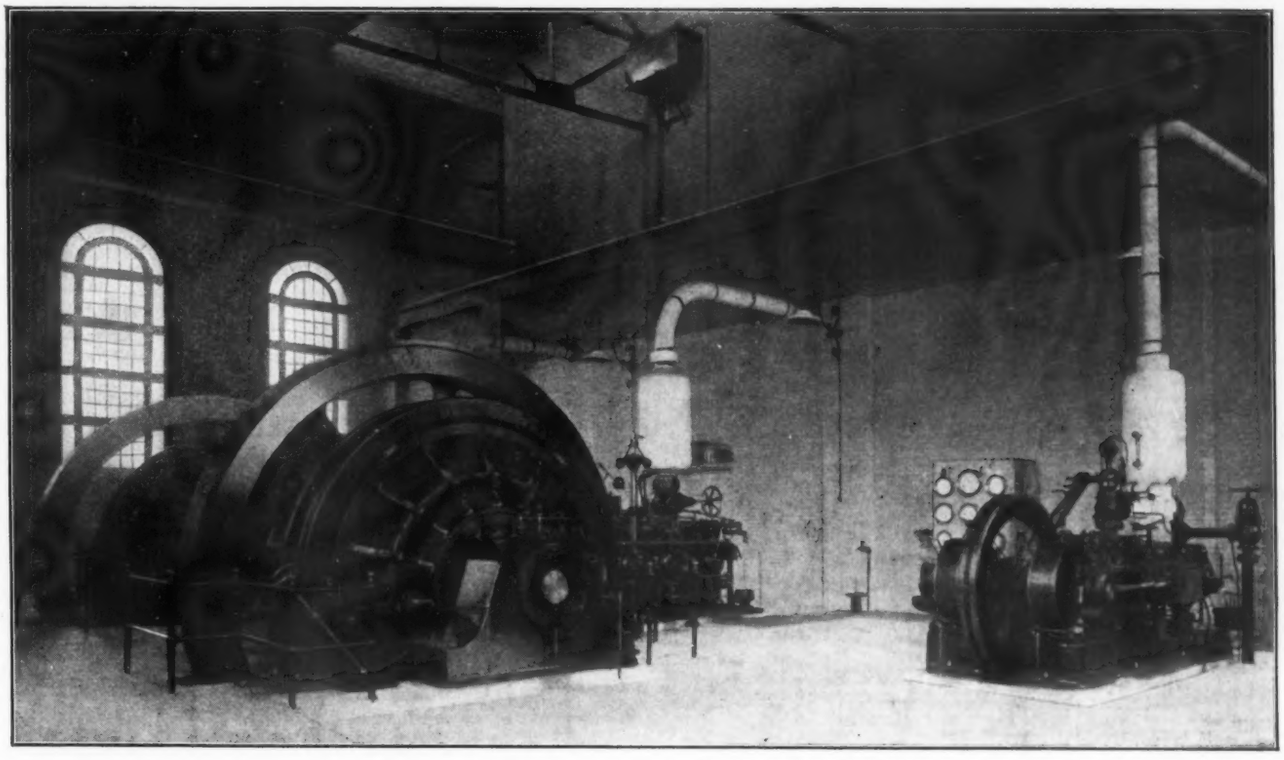


FIG. 4. GENERATING UNITS AND AIR COMPRESSOR

An interesting feature is the installation of two multiport back-pressure valves, one in the exhaust line leading up to the heater and the other in the free exhaust line leading to the atmosphere. The purpose of the two valves is that by proper manipulation of the free exhaust valve a certain predetermined back pressure may be carried in the main exhaust line for heating or drying purposes. The surplus steam escapes to the heater and by means of the second back-pressure valve, any surplus here may escape to atmosphere. This valve is set above atmospheric pressure.

A feature of interest and somewhat out of the ordinary is the ring header over the boilers. The leads from the boilers are tapped alternately to either side of the loop, and the piping to the engine units is brought off in the same way. Damage to one section of the header will not compel a shutdown, as steam from the boilers may pass in either direction to the pipes supplying the prime movers. From the boiler outlets to the top of the header the piping forms a V-bend, and a similar bend occurs in the lead to each engine, as the pipe leads out of the top of the header and passes down under the breeching before

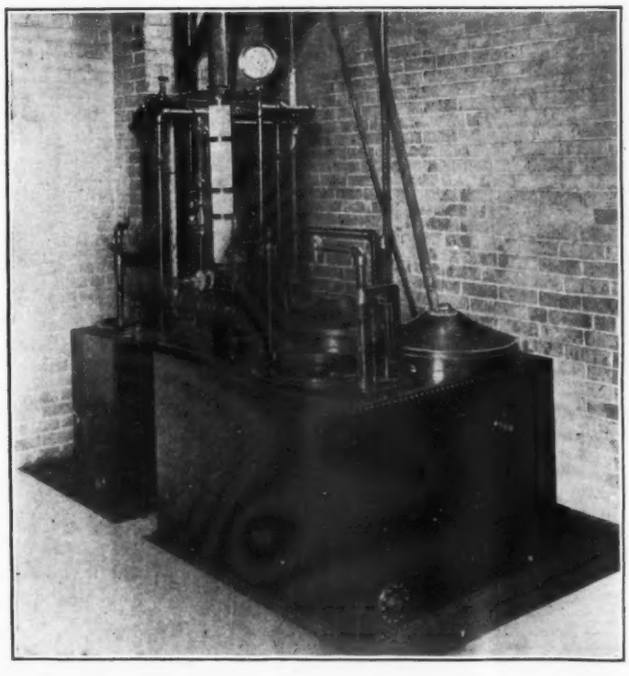


FIG. 5. OIL FILTERING AND CIRCULATING SYSTEM

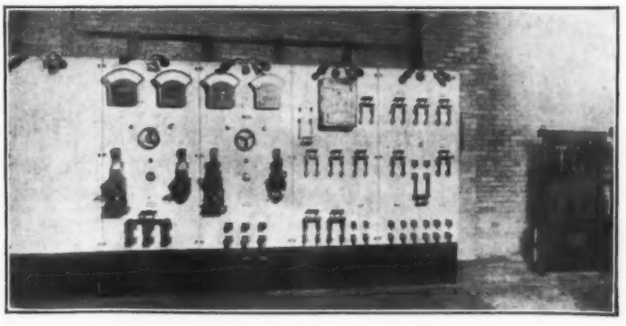


FIG. 6. SWITCHBOARD AND PANEL FOR FIRE-PUMP MOTOR

it enters the engine room. The bends in the header and the piping relieve the stresses set up by expansion or contraction. Another feature is the pipe supports for the header. At the turns these rest on the floor and along the runs are based on the boiler tops. These supporting pipes are 4 in. in diameter. A 2x⅜-in. piece of strap iron is bent to fit snugly around the header. The two ends are bent at right angles and extend about 4 in. into the supporting pipe. A bolt passing through the pipe and the strap ends makes the support secure and the pipe cover-

ing extending down over the joint gives a neat and attractive finish.

Generating Equipment

When turning out the products for which the works was intended continuous service will be required from the power plant. The load night and day will run about

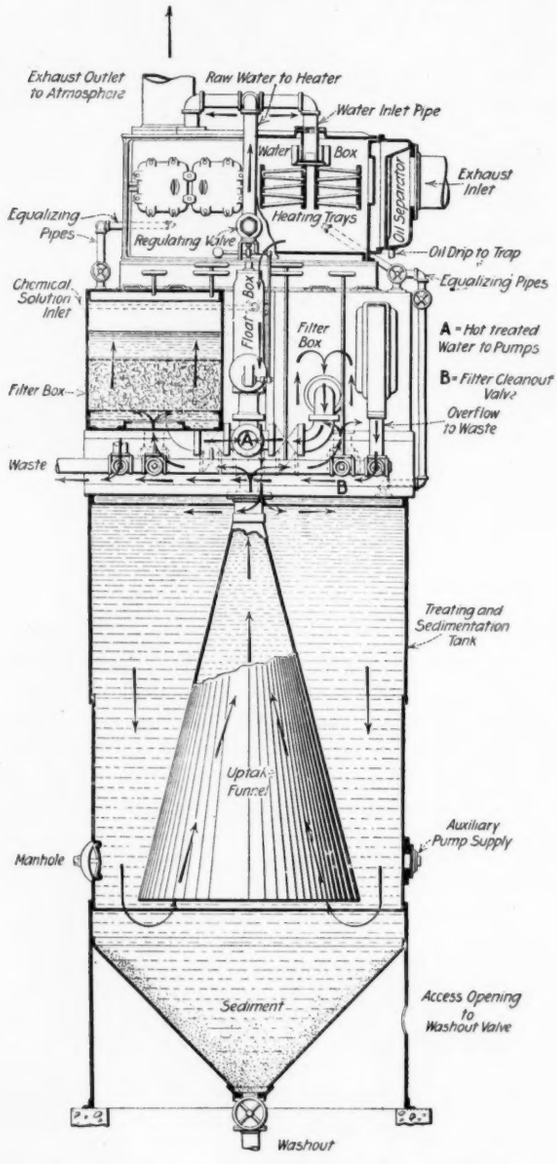


Fig. 7. Sectional View of Purifier and Heater

the same, and reliability of service will be of the utmost importance, as discontinuance would entail a large loss in the product under manufacture. For this reason duplicate generating units were installed, each capable of carrying the load while the other is held ready for service on short notice.

The engines are heavy slow-speed Corliss units, with cylinders 24x42 in., making 90 r.p.m., while the generators to which they are directly connected are really 600-kw. compound-wound direct-current machines, although rated at 400 kw., owing to the low speed. These massive units are expected to care for the load with a minimum of upkeep and, above all, to give reliable service for years to come. The steam rate, although good for an engine of this type, is not of prime importance, as all of the exhaust steam will be utilized winter and summer.

Steam Velocities

Steam is supplied to each engine through an 8-in. pipe having a sectional area of 0.3474 sq.ft., or ⅛ sq.in. per kilowatt of rating. At 30 lb. per kw.-hr. the engine, at 50 per cent. overload, would require 18,000 lb. of steam, or 300 lb. per min. At 150 lb., and dividing by the area of the pipe, 0.3474 sq.in., gives for continuous flow a velocity of 2383 ft. per min. At quarter cutoff, however, steam would flow only one-fourth of the time, so that to supply the above amount of steam would require a velocity close to 9000 ft. per min. A receiver of course tends to equalize the flow. The longer the intervals between steam admissions, the larger this receiver should be. In the present case it was made 2¼ times the volume of the cylinder.

The exhaust piping is 10 in. in diameter, and for each kilowatt of rating it has an area of 0.197 sq.in. For 50 per cent. overload and continuous flow the velocity of the exhaust would be close to 12,000 ft. per min. At normal load this would reduce to 8000 ft.

Special Oiling System

For lubrication of the bearings the engines are equipped with a complete oil-filtering and circulating system. Oil from the various bearings flows to one of two large tanks in the basement. The other is used to receive barrels of fresh oil and quickly dispose of the supply. By means of compressed air oil from either tank may be raised to a gravity tank in the engine room. From here it passes through a separator and refuse tank, where most of the impurities are removed. It then passes on through fine filtering surfaces into a drip tank from which it is raised by small steam pumps belonging to the system to an 80-gallon tank high up on the engine-room wall, supplying the engines. Force-feed pumps lubricate the cylinders.

A thoroughly equipped switchboard, a gage board, an air compressor and a fire pump complete the equipment of the plant. The gage board contains indicating pressure gages for the boilers, engine throttles, exhaust header and

PRINCIPAL EQUIPMENT OF GRANBY PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
3	Boilers	Horizontal water-tube	350-hp	Generate steam	150-lb. pressure, stokers, natural draft	Babcock & Wilcox Co.
3	Stokers	Chain grate	70-sq.ft	Serve boilers		Babcock & Wilcox Co.
1	Stack	Tile and concrete	8x185-ft	Serve boilers		Wiederholdt Construction Co.
1	Crane	Locomotive	10-ton	Unloading coal, etc		Brown Hoisting Machinery Co.
1	Heater and purifier	Sorge-Cochrane	5420-gal. per hr.	Heat and purify feed water	Exhaust steam	Harrison Safety Boiler Works
2	Pumps	Duplex	10x6x10-in	Pump boiler feed water	150-lb. steam	Epping-Carpenter Co.
1	Fire pump	Centrifugal	6-nozzle	Fire protection	Driven by 150-hp. Sprague motor	Alberger Pump & Condenser Co.
2	Engines	Simple Corliss	24x42-in	Main units	150-lb. steam, 90 r.p.m	Fulton Iron Works
2	Generators	D.-c. compound wound	400-kw	Main units	110 volts, 90 r.p.m	Sprague Electric Co.
1	Oiling system	Circulating and purifying		Serves main units and air compressor		S. F. Bowser & Co.
3	Oil pumps	Sight-feed	Two and six feed	Oil engine and compressor cylinders		Richardson-Phenix Co.
1	Air Compressor	Duplex	12, 19 and 12x 14-in	Compress air for tools, etc.	700 cu.ft. free air, 100 lb., 152 r.p.m.	Chicago Pneumatic Tool Co.
1	Crane	Traveling	10-ton	Serve engine room		Whiting Foundry Equipment Co.

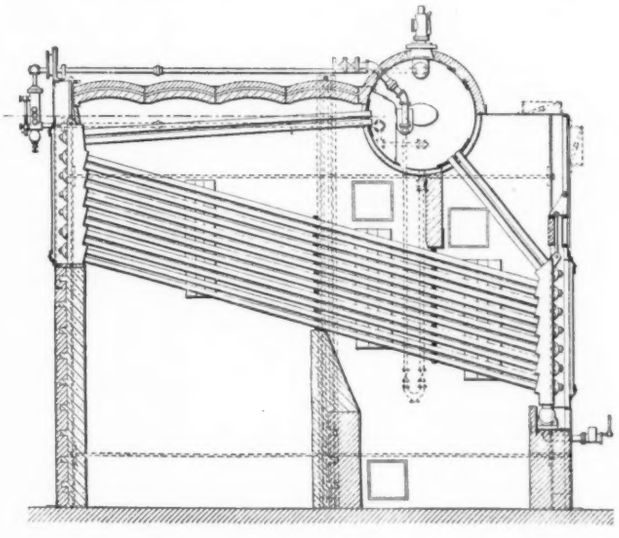
the compressed-air receiver, and recording gages for boiler pressure, temperature of feed water and altitude of water in elevated supply tank. This tank has a capacity of 120,000 gal. and is 120 ft. above the ground. It may be thrown in series with a six-nozzle motor-driven fire pump and add its head to the 150 lb. which the pump will supply. The air compressor is of the duplex type, having a capacity to deliver 700 cu.ft. of free air at 100 lb. pressure when making 152 r.p.m. The cylinders are 12, 19 and 12 by 14 in.

From the plant water and steam piping, cables and wiring are conducted to the various buildings through a tunnel. The piping is supported in the usual way on one side of the tunnel, and on the other side the cables are laid in angle iron resting on notched brackets which project from the concrete wall. This keeps the cables from sagging and allows ready inspection.

Including building chimney and all equipment, the total cost of the plant was $110,000, or $137.50 per kilowatt of rated output. Ruebel & Wells C. E. Co., of St. Louis, is responsible for the design and erection.

New Flanner Boiler Setting

Engineers familiar with the Flanner water-tube boilers know that they were suspended at the front end, by pendulum rods, the rear end resting upon ball bearings placed under a saddle upon which the mud drum rested.



FLANNER BOILER SUSPENDED BY PENDULUM RODS

Thus the weight of the rear end of the boiler was sustained by the mud drum.

In the new method employed in the boiler setting no change has been made in suspending the front end of the boiler. An improvement has been made in suspending the rear end in that pendulum rods are used, as shown in the illustration. This relieves the boiler of expansion and contraction stresses, because both the front and rear headers are individually suspended independent of the steelwork, and swing clear of the brick setting.

The mud drum of this boiler, manufactured by the Flanner Water-Tube Boiler Co., Akron, Ohio, swings free of the brickwork below it, and is protected from the furnace heat by a baffle wall.

JUST FOR FUN

A SIGN OF A HOT FIRE, AT LEAST

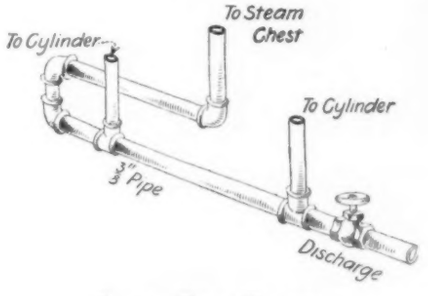
The new fireman, in addition to being a very sociable person, was not averse to imparting a modicum of his fund of information. One evening, he prophesied rain because the water was boiling away out of the boilers very fast, and he had always noticed that this was a sure sign of rain.—*William E. Dixon, Cambridge, Mass.*

WHAT'S THE ANSWER?

Investigating a complaint that certain offices were not comfortably heated, the engineer found that the radiators were entirely too small and made a remark to that effect in the hearing of the occupant, who said, with the air of one who had put over an unanswerable one: "What's the use of talking about putting in larger radiators? You haven't steam enough to heat those little ones." Query: How can the engineer express and relieve himself adequately under such circumstances in a few short words?—*E. W. Sears, Newark, N. J.*

EXTREME ECONOMY (?)

A few years ago an engineer obtained a position in a small woodworking shop. The owner, who had a special license, in showing the new engineer around the plant, told him in a friendly way not to make any changes or repairs unless he (the owner) was with him. To use his own words, "If I do a job myself or see it done, I know it is done right." By way of reply the engineer asked him who piped up the cylinder cocks and steam chest drip. "I did," replied the owner. "You can see that I saved two ⅜-in. valves. Some men would have used three valves, where one does the work."—*C. E. Bascom, Westfield, Mass.*



SAVED TWO VALVES

A BAD WAY TO DISPOSE OF A RUBBER BELT

In an oil-burning plant, operated smokelessly to the great satisfaction and pride of all concerned, a 10-in. rubber belt frequently gave trouble, but was patched up and the odd pieces kept for more patches until patience was nearly as tattered as the belt. In order to get a new belt the reserve pieces were disposed of by cremation in the combustion chamber. In about two minutes the stack was belching the thickest of black smoke! A new belt was ordered in, but the thoughtless engineer was ordered out.

Moral: Be careful what you attempt to hide in the combustion chamber.—*A. G. Solomon, Chicago, Ill.*

Comparison of Electric Light and Power Rates

By Judson C. Dickerman*

SYNOPSIS—The rates for different classes of service from residence lighting to the wholesale consumer for representative American cities are compared by means of charts.

As part of the evidence prepared to show the Pennsylvania Public Service Commission that the system of rates of the Philadelphia Electric Co. was unsystematic, chaotic, and imposed excessive charges upon most consumers, official printed rate schedules were obtained and charts constructed showing the relations between rates for the various classes of service in force in a number of Northern and Eastern cities. The schedules were studied by the writer and his assistant, of the Bureau of Gas, Philadelphia, and whenever uncertainty existed as to the meaning of the printed schedules the corporations concerned were written to for an explanation, which was always courteously given. Final calculations, however, were not sent to be checked by the corporations, although a few companies received copies of the charts, and neither by them nor by testimony before the commission was any criticism made as to accuracy. The rates are those in force during the latter part of 1914 and the early part of 1915, and include the recently revised schedule of the New York Edison Co. as ordered by a decision of the New York Public Service Commission in March, 1915, fixing the maximum at 8c. per kw., with equivalent reductions in other rates.

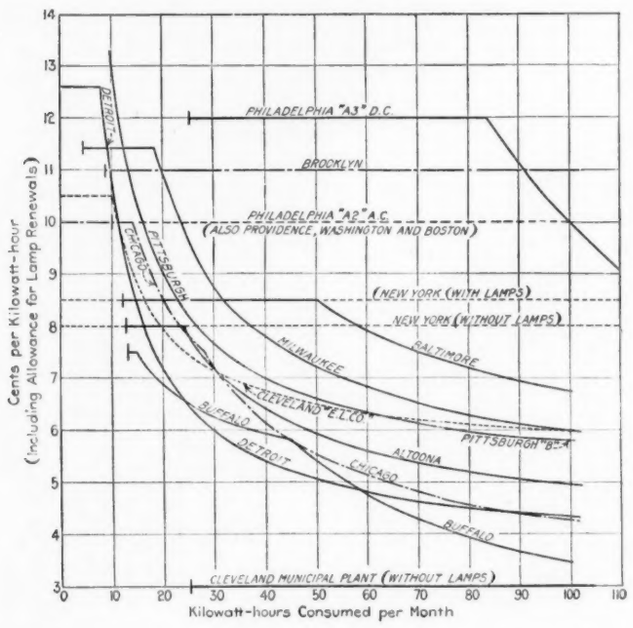


Fig. 1. Rates for Residence Lighting—8-Kw. Installation

Charts were prepared for each city, showing all the rates not involving temporary or special service in addition to supplying electric energy and renewing ordinary incandescent lamps. In general, curves covering demands of 1 kw., 10 kw., 50 kw., 100 kw., 200 kw. and 1000 kw. were constructed where such demands were applicable. The charts thus prepared furnished an excellent opportunity to observe the following points:

I. For the same schedule, difference in rates charged very small-, medium-small-, moderately large- and very large-demand consumers.

II. For the same-demand consumers, the differences in rates between light and power, limited-hour, and long- and short-hour users.

III. The possible inconsistencies due to the discount systems.

IV. The possibilities of discrimination due to two or more schedules apparently applicable to the same circumstances, but involving different costs for the same service.

V. The departure from the basic principles upon which most of the schedules were constructed by adding somewhat special schedules.

As an example, under I, taking as a fair basis of comparison 4 hours' use per working day of the demand.

	Power Cents per Kw.-Hr.	Light Cents per Kw.-Hr.
Boston:		
Rate for 1-kw.-demand	9.7	10.0
Rate for 10-kw. demand	5.5	10.0
Rate for 200-kw. demand	3.6	5.5
Milwaukee:		
Rate for 1-kw. demand	6.7	6.7
Rate for 10-kw. demand	6.3	6.8
Rate for 200-kw. demand	3.6	4.1
Providence:		
Rate for 1-kw. demand	11.0	...
Rate for 10-kw. demand	9.0	...
Rate for 200-kw. demand	2.8	...
Buffalo:		
Rate for 1-kw. demand	4.4	6.7
Rate for 10-kw. demand	4.5	5.0
Rate for 200-kw. demand	3.5	4.0
Cleveland:		
Rate for 1-kw. demand	6.1	6.6
Rate for 10-kw. demand	4.4	4.9
Rate for 200-kw. demand	2.6	3.1
Chicago:		
Rate for 1-kw. demand	5.7	5.7
Rate for 10-kw. demand	5.7	5.7
Rate for 200-kw. demand	4.6	4.6
Detroit:		
Rate for 1-kw. demand	5.2	5.8
Rate for 10-kw. demand	5.1	4.8
Rate for 200-kw. demand	4.4	...
Philadelphia:		
Rate for 1-kw. installation	8.2	8.2
Rate for 10-kw. installation	5.8	8.2
Rate for 200-kw. installation	2.8	8.2

This also shows the differences between power and light. A difference of one-half cent per kilowatt-hour is commonly considered as about equal to the cost of lamp renewals to light customers.

Under III, the effect is not of marked importance, but in some few cases it actually makes the net rate a little higher for a somewhat larger consumer compared with a smaller one.

Under IV, most of the companies have conflicting rates requiring that someone notice when a customer's business so changes that he will be entitled to a better rate (or *vice versa*) under a different schedule than the one originally applied. This is particularly noticeable in Philadelphia, Milwaukee and Providence, while it is wholly or practically absent in Buffalo, New York and Altoona. Fig. 12 shows this plainly.

Under V, most of the companies, besides the rates based on the number of hours' use per month or day of the de-

*Chief, Bureau of Gas, Philadelphia.

mand, have certain low flat-rate quantity schedules, apparently designed to provide for those customers of considerable demand, but with such intermittent and occasional use of current that the total consumption is relatively small. Under the systematic schedules, such consumers might pay much higher than the usual maximum of 8 to 10 cents and concession is given them in a low rate, probably on the basis of an especially large diversity factor. Cleveland, Milwaukee, Detroit and Altoona are marked examples, while Chicago, Buffalo and Boston have no such schedules.

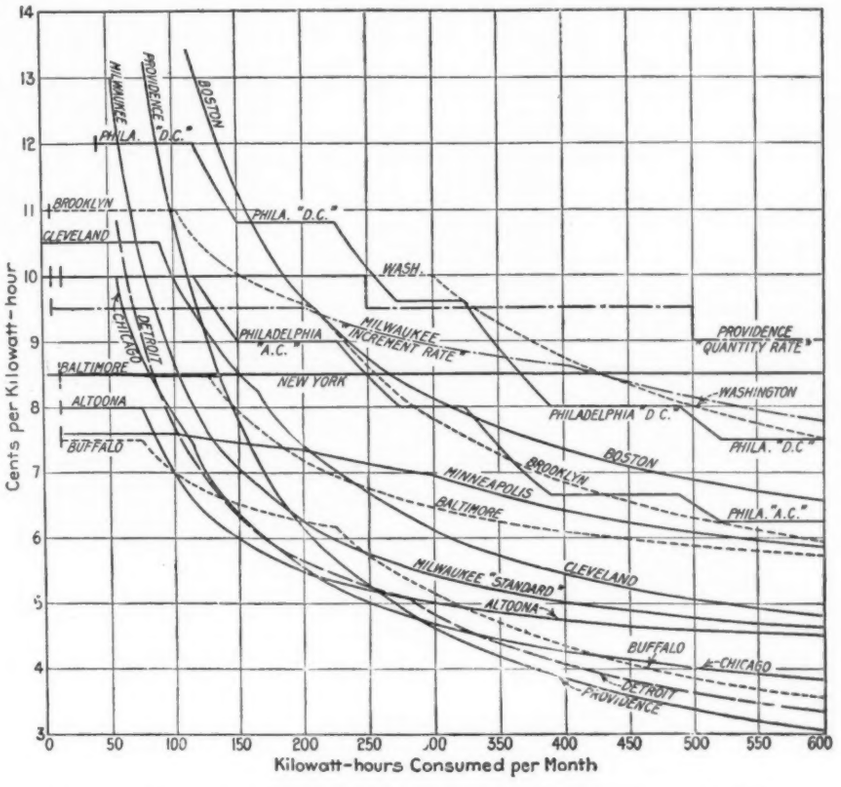


FIG. 2. RATES FOR COMMERCIAL LIGHTING APPLICABLE TO 2.5-KW. INSTALLATION

These charts, covering the schedules in Boston, Providence, Philadelphia, Baltimore, Washington (D. C.), Altoona (Penn.), Buffalo, Cleveland, Detroit, Chicago and Milwaukee, are not here reproduced, but copies may be had from the Bureau of Gas, City of Philadelphia, by those interested.

As a means of direct comparison of the rates charged in the different cities for the same character of service, the charts were recalculated for the following classes of service and size of the installation or demand:

Fig. 1. Residence lighting and incidental power, eight principal rooms or 0.8-kw. installation.

Fig. 2. Commercial lighting—stores, offices, small factories, 2.5-kw. installation.

Fig. 3. Small power, 10-hp. installed.

Fig. 4. Wholesale power, often including lighting without free lamps; 200-kw. installed or 110-kw. maximum demand.

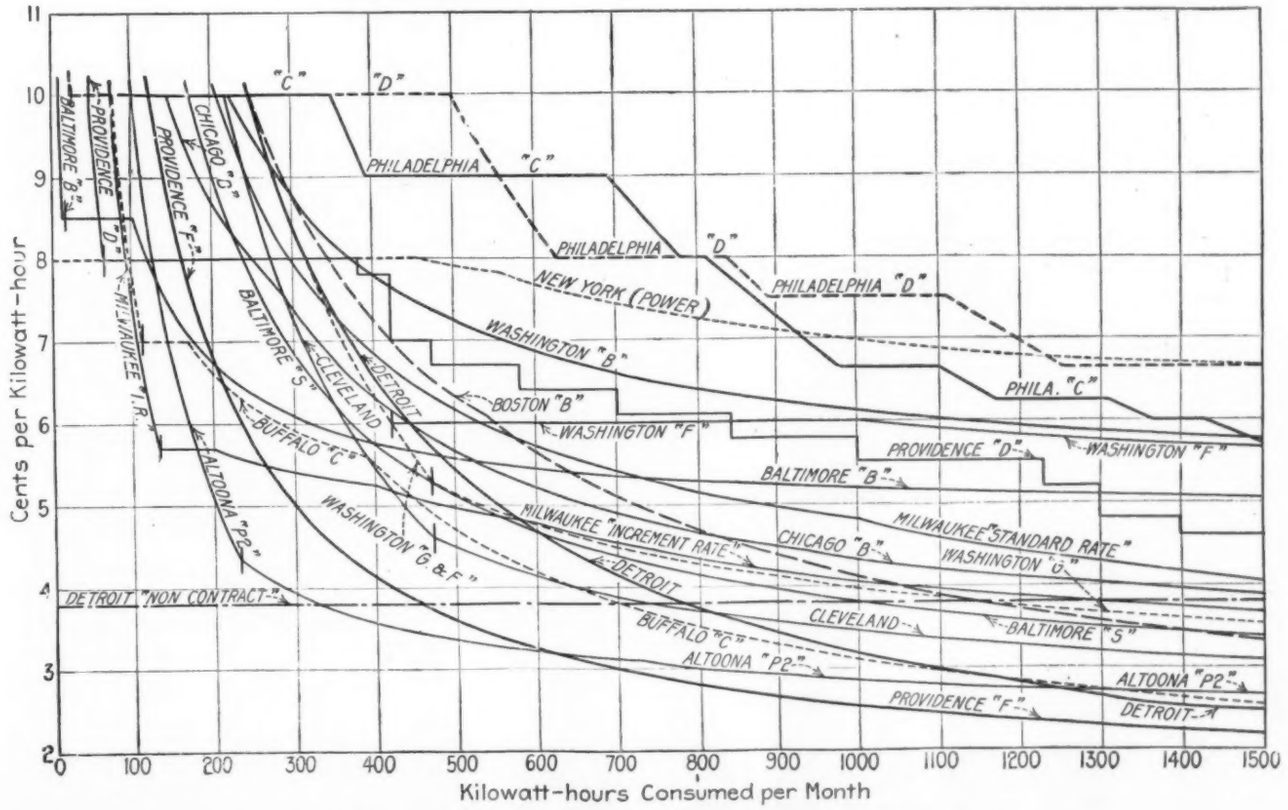


FIG. 3. RATES APPLICABLE TO A 10-HP. INSTALLATION

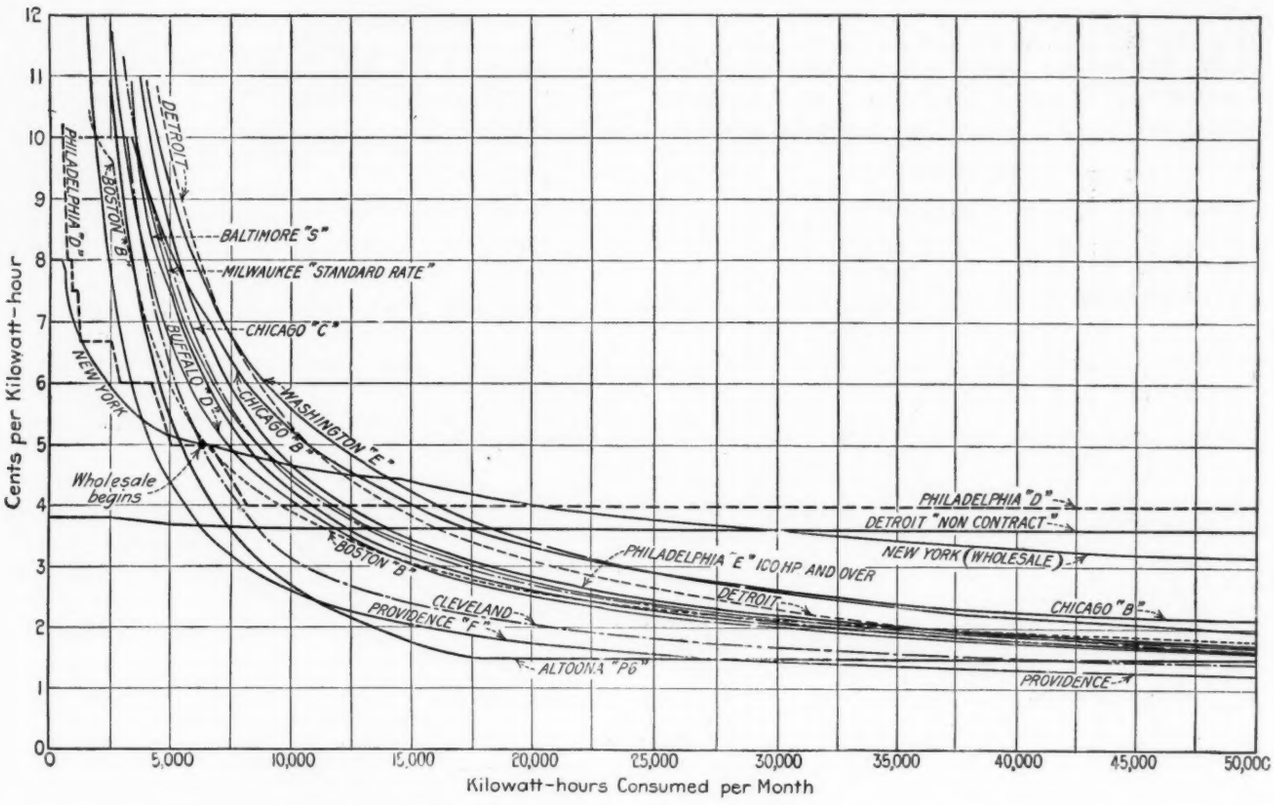


FIG. 4. POWER RATES, APPLICABLE TO 200-KW. INSTALLATION

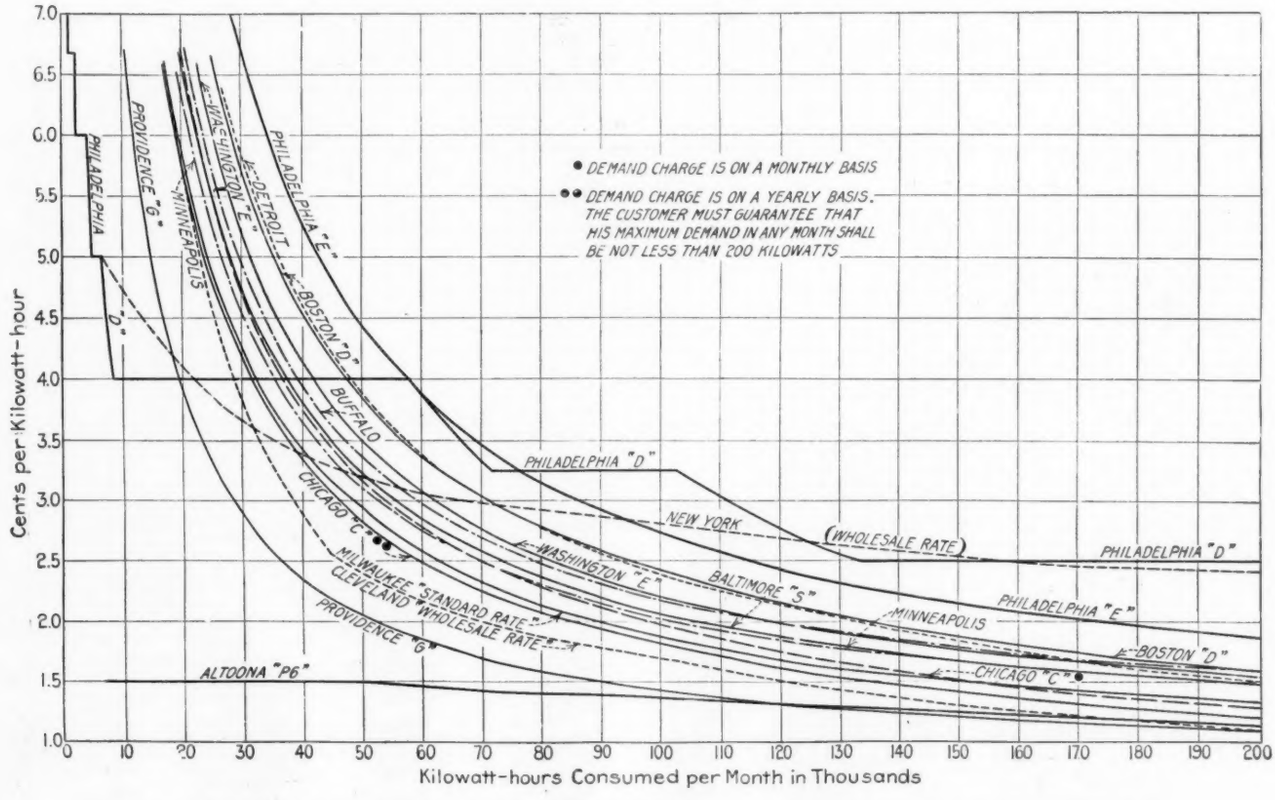


FIG. 5. POWER RATES APPLICABLE TO 1000-KW. INSTALLATION; MAXIMUM DEMAND 500 KW.

Fig. 5. Very large wholesale service, without lamps; 1000-kw. installed or 500-kw. demand.

Fig. 6. High-tension service, 1000-kw. maximum demand, and high-tension, guaranteed demand for traction and railway, 15,000-kw. maximum demand at 35 per cent. load factor.

When the schedule specified the percentage of installation to be taken as a maximum demand, it was used, other-

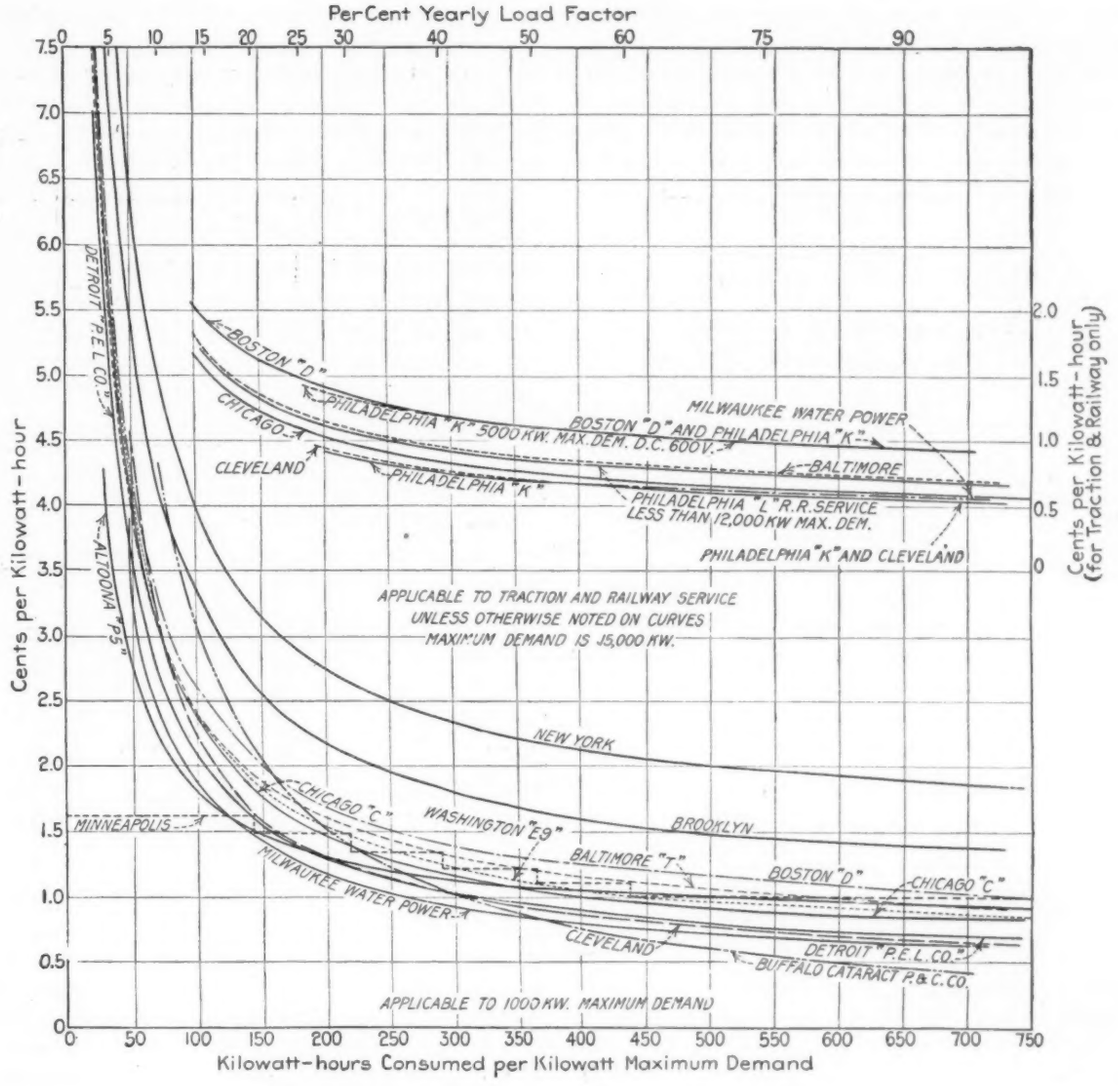


FIG. 6. POWER RATES FOR HIGH-TENSION SERVICE

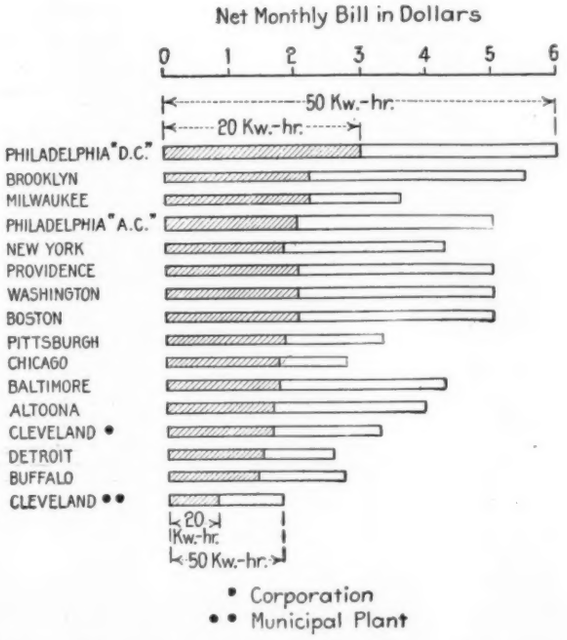


FIG 7. MONTHLY BILLS FOR RESIDENCE LIGHTING—0.8-KW. INSTALLATION

wise the factor most commonly used in the literature on the subject was employed. Rates for lighting are on the basis of free lamp renewals (except where otherwise specified), the rates of companies not giving free lamp service being increased one-half cent per kilowatt-hour.

The schedules for residence lighting, except in a few cases such as Boston, where a fixed flat quantity rate with

TABLE 1. RESIDENCE LIGHTING

The schedule indicated in printed form as applicable to residence lighting was used and the method given for figuring the maximum demand taken either from the printed schedule or from correspondence with the company concerned.

	20 Kw.-Hr. Consumed per Month		50 Kw.-Hr. Consumed per Month	
	Cents per Kw.-Hr.	Net Bill	Cents per Kw.-Hr.	Net Bill
Philadelphia, d.c.	...	$3.00*	12.00	$6.00
Brooklyn	11.00	2.20	11.00	5.50
Milwaukee	10.95	2.19	10.00	5.00
Philadelphia, a.c.	10.00	2.00	8.00	4.00
New York†	8.00	1.80	10.00	5.00
Providence	10.00	2.00	10.00	5.00
Washington	10.00	2.00	10.00	5.00
Boston	10.00	2.00	8.50	4.25
Pittsburgh	9.00	1.80	7.20	3.60
Chicago	8.50	1.70	6.60	3.30
Baltimore	8.50	1.70	6.50	3.25
Altoona	8.00	1.60	5.92	2.96
Cleveland (Illuminating Co.)	8.00	1.60	5.51	2.75
Detroit	7.20	1.44	5.40	2.70
Buffalo	6.90	1.38	5.05	2.52
Cleveland (municipal)	...	.75*	3.50 (If lamps are included)	1.75

*Note—Minimum bill. †Does not include lamp renewals; where lamps are furnished, rate is increased by ½c. per kw.-hr.

no chance for discount exists, are not directly comparable. Some are based on the number of rooms, others on the number of lamp sockets, others on a variable percentage of the installation as estimated demand. Therefore, it was necessary to take some typical residence with a probable installation. The writer took eight principal rooms,

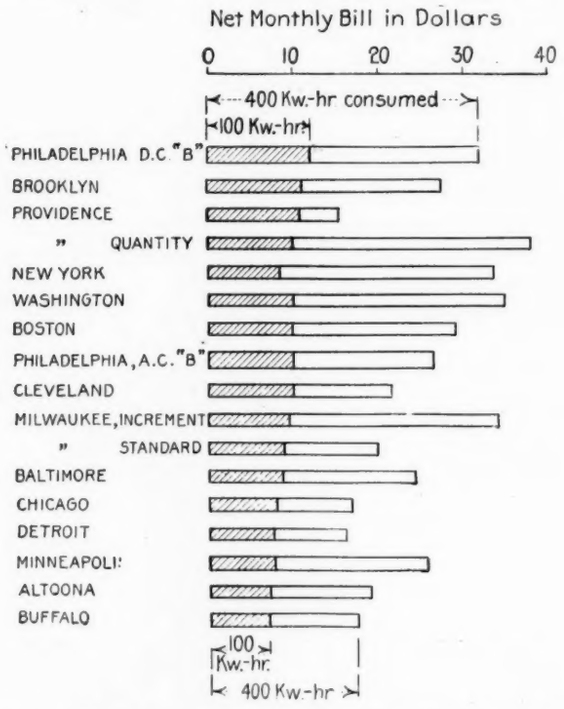


FIG. 8. MONTHLY BILLS FOR COMMERCIAL LIGHTING—2.5-KW. INSTALLATION

and 0.8-kw. installation as being representative in American cities of a large number of users of electricity. A short, heavy vertical line at the beginning of a curve indicates the minimum payment exacted, which is equal to the rate in cents times the number of kilowatt-hours corresponding to the location of the vertical line.

Examination of Figs. 1 and 7 and Table 1 calculated from them shows that the Middle West cities get electricity under a system which encourages long-hour consumption, while the Eastern cities still cling to a fixed high price, independent of the hours of use of the demand.

Commercial-lighting schedules are more generally based on the use of the demand. Rates in the Eastern cities are generally higher than those of the Western cities. The chart (Fig. 2) shows the different charges possible under two different schedules in one company's list, as the two Milwaukee and the two Providence rates. Noteworthy is the two-cent additional charge for direct-current service in the downtown district in Philadelphia over that charged for alternating-current energy, a practice not existing anywhere else.

The comparison of rates for a 10-hp. installation (Figs. 3 and 9) should be of wide interest, as it is a typical small-business service. Here again, the same company may have two or more schedules which are applicable, the choice varying with different amounts of consumption. Philadelphia, Providence, Washington, Detroit, etc., show marked differences. The general distinction between Eastern and Western city rates is disturbed to some extent by the policy of exceptionally low rates to power users offered in some Eastern cities. The schedules sometimes base the rate on the installed capacity, and sometimes on the estimated or determined maximum demand, making it impossible to directly compare the rates without some such calculation as has been done in the case of these charts.

In the case of rather large installations, as of 200-kw. capacity (Figs. 4 and 10) all but the Philadelphia and New York schedules base the rate upon the maximum demand. While, apparently, the Philadelphia schedule reads

TABLE 2. COMMERCIAL LIGHTING

The maximum demand percentage used was that given in the schedules; where none was given, 80 per cent. of the installation was taken.

Note the Philadelphia Electric Co.'s different rates for alternating-current and direct-current. No other company makes any distinction in rate for long-hour use; rates in many other cities drop much faster than in Philadelphia.

100 Kw.-Hr. Consumption per Month Equivalent to 1.6 Hr. Daily Use of Installation			400 Kw.-Hr. Consumption per Month Equivalent to about 6.4 Hr. Daily Use of Installation		
	Cents per Kw.-Hr.	Net Bill		Cents per Kw.-Hr.	Net Bill
Philadelphia, d.c.	12.00	$12.00	New York (including lamps)*	8.50	$34.00
Brooklyn	11.00	11.00	Providence Q. R.	9.50	38.00
Providence	10.90	10.90	Washington	8.75	35.00
Cleveland	10.00	10.00	Milwaukee I. R.	8.62	34.48
Philadelphia, a.c.	10.00	10.00	Philadelphia, d.c.	8.00	32.00
New York (including lamps)*	8.50	8.50	Boston	7.35	29.40
Washington	10.00	10.00	Brooklyn	6.85	27.40
Providence Q. R.	10.00	10.00	Philadelphia, a.c.	6.67	26.68
Boston	10.00	10.00	Minneapolis	6.40	25.60
Milwaukee I. R.	9.50	9.50	Baltimore	6.10	24.40
Milwaukee	8.70	8.70	Cleveland	5.45	21.80
Baltimore	8.50	8.50	Milwaukee	5.00	20.00
Chicago	7.85	7.85	Altoona	4.75	19.00
Detroit	7.60	7.60	Buffalo	4.35	17.40
Minneapolis	7.60	7.60	Chicago	4.26	17.04
Altoona	7.00	7.00	Detroit	4.06	16.24
Buffalo	7.00	7.00	Providence	3.85	15.40

*Rate ½c. per kw.-hr. where lamps are not furnished.

TABLE 3. 10-HP. INSTALLATION

The maximum demand equivalent to 10-hp. installation is that given in the official schedules of the various companies; when not given, 70 per cent. was used. Many companies have more than one schedule with different rates applicable to the same situation, notably Philadelphia, Washington, Providence, etc. At some consumptions one schedule is cheaper; at another consumption, another schedule is cheaper.

300 Kw.-Hr. Consumer per Month Equivalent to 1.5 Hr. Daily Use of Installation			600 Kw.-Hr. Consumed per Month Equivalent to About 3 Hr. Daily Use of Installation			1000 Kw.-Hr. Consumed per Month Equivalent to About 5 Hr. Daily Use of Installation		
	Cents per Kw.-Hr.	Total Bill		Cents per Kw.-Hr.	Total Bill		Cents per Kw.-Hr.	Total Bill
Philadelphia "C"	10.00	$30.00	Philadelphia "C"	9.00	$54.00	Philadelphia "D"	7.50	$75.00
New York	8.00	24.00	Philadelphia "D"	8.35	50.10	New York	7.00	70.00
Washington "B"	8.75	26.25	New York	7.66	46.00	Philadelphia "C"	6.67	66.67
Boston "B"	8.75	26.25	Washington "B"	6.90	41.40	Cleveland (quantity)	6.25	62.50
Detroit	8.40	25.20	Providence "D"	6.40	38.40	Washington "B"	6.12	61.20
Washington "F" and "G"	8.40	25.20	Cleveland (quantity)	6.25	37.50	Washington "F"	6.00	60.00
Providence "D"	8.00	24.00	Washington "F"	6.00	36.00	Providence "D"	5.50	55.00
Milwaukee S. R.	7.95	23.85	Milwaukee S. R.	5.70	34.20	Baltimore "B"	5.20	52.00
Chicago "B"	7.40	22.20	Boston "B"	5.62	33.72	Milwaukee "S. R."	4.80	48.00
Cleveland R. commercial	7.25	21.75	Baltimore "B"	5.45	32.70	Chicago "B"	4.30	43.00
Baltimore "S"	6.85	20.55	Chicago "B"	5.20	31.20	Boston "B"	4.10	41.00
Cleveland (quantity)	6.25	18.75	Milwaukee I. C.	4.80	28.80	Milwaukee "I. R."	4.05	40.50
Baltimore "B"	6.10	18.30	Washington "G"	4.75	28.50	Washington "G"	3.98	39.80
Buffalo	5.90	17.70	Detroit, contract	4.70	28.20	Detroit, noncontr.	3.80	38.00
Milwaukee I. R.	5.40	16.20	Baltimore "S"	4.70	28.20	Baltimore "S"	3.80	38.00
Providence "F"	5.00	15.00	Buffalo "C"	4.20	25.20	Cleveland (retail contract)	3.45	34.50
Altoona	3.92	11.76	Cleveland, retail contract	4.12	24.72	Detroit (contract)	3.20	32.00
Detroit, noncontract	3.80	11.40	Detroit, noncontract	3.80	22.80	Buffalo "C"	3.10	31.00
			Providence "F"	3.25	19.50	Altoona	2.85	28.50
			Altoona	3.20	19.20	Providence "F"	2.55	25.50

lower than most cities, being based on installed capacity, the actual rate referred to the probable demand brings it among the highest. For instance, 100 hr. use per month of the installed capacity equals 181 hr. use of the demand, and the rate for the 181 hr. use of 110-kw. demand in most of the other cities is considerably below that

TABLE 4. 200 KW. INSTALLATION

The maximum demand is taken as 55 per cent. of the connected load or installation. Philadelphia "E" rate is higher for short-hour users than Philadelphia "D" rate. Philadelphia "D" rate is the lowest (with one exception) for short-hour consumers.

5000 Kw.-Hr. Consumed per Month Equivalent to 1 Hr. Use of Installation per Day			25,000 Kw.-Hr. Consumed per Month Equivalent to 5 Hr. Use of Installation per Day		
	Cents per Kw.-Hr.	Total Bill		Cents per Kw.-Hr.	Total Bill
Detroit (reg. bill)	9.60	$480.00	Philadelphia "D"	4.00	$1000.00
Washington	9.10	455.00	New York	3.83	958.33
Philadelphia "E"	8.35	417.50	Detroit (non-contr.)	3.61	902.50
Chicago "B"	8.10	405.00	Washington	2.90	725.00
Chicago "C"	7.85	392.50	Chicago "B"	2.90	725.00
Milwaukee	7.60	380.00	Detroit	2.65	662.50
Baltimore	7.40	370.00	Philadelphia "E"	2.48	620.00
Buffalo	6.60	330.00	Milwaukee	2.40	600.00
Cleveland	6.20	310.00	Chicago "C"	2.36	590.00
Boston	5.90	295.00	Boston "B"	2.30	575.00
Altoona	5.40	270.00	Baltimore	2.30	575.00
New York	5.15	255.75	Buffalo	2.20	550.00
Philadelphia "D"	5.00	250.00	Cleveland	1.82	455.00
Providence	4.30	215.00	Providence	1.60	400.00
Detroit (non-contr.)	3.70	185.00	Altoona	1.50	375.00

for 100 hr. use of the installed capacity in Philadelphia, although direct comparison of the Philadelphia 100 hr. use with 100 hr. use of the demand in the other cities would show Philadelphia apparently low. The Boston and Providence rates are well below those of the cities where real attempts have been made to see that big consumers pay a fair proportion of the cost of serving them. The 200-kw. and the 1000-kw. installation charts (Figs. 4 and 5) show well the effect of the "quantity" schedules

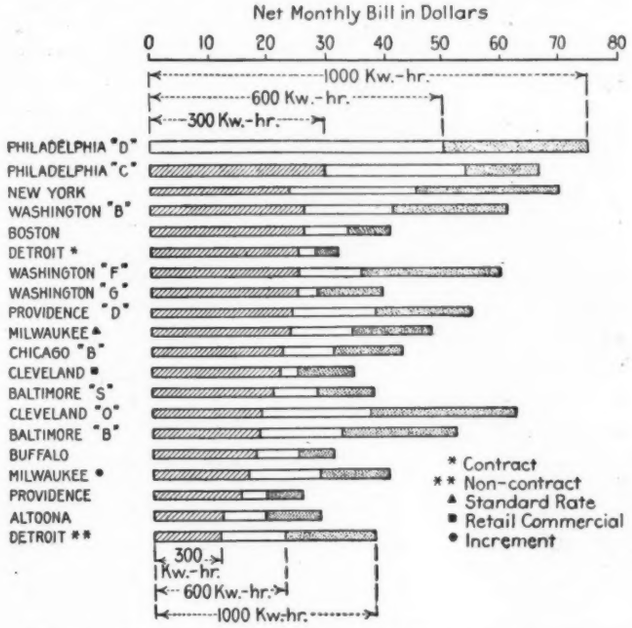


FIG. 9. MONTHLY BILLS FOR 10-HP. INSTALLATION

(which are not in the least based on the demand) in highly favoring the large-demand short-hour consumer. Note the Philadelphia "D" curve; also that the companies supplying mostly water-generated energy—as Baltimore, Buffalo, Minneapolis, and to a less extent Milwaukee—have rates higher than the strictly steam-driven systems of Cleveland and Chicago.

In some respects the chart offering the most food for thought is that showing high-tension and traction-service rates (Fig. 6). Here are shown the rates for very large business commonly guaranteeing a load factor about equal to the load factor of the whole system, a business requiring an independent distribution system and in many cases

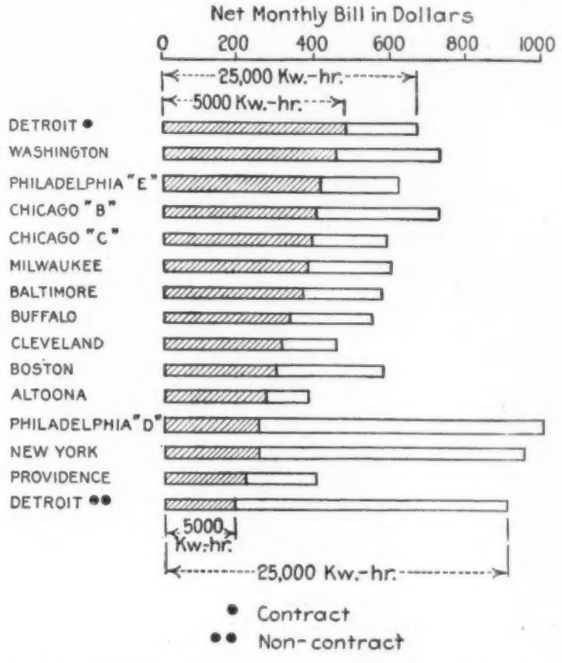


FIG. 10. MONTHLY BILLS FOR 200-KW. INSTALLATION

practically a complete power-plant installation primarily for traction purpose. With such a load factor and a business whose great demand comes at the periods of great use by the general community, the rate established must either represent the real total costs of producing and distributing wholesale electricity plus a profit, or else a gross and unjustified deprivation of the owners from profits, or the imposition of an unfair burden on the balance of the consumers to make up the deficit. Also, in the case of Philadelphia is exhibited the probable extra cost of furnishing equipment and operating to convert alternating

TABLE 5. 1000-KW. INSTALLATION OR 500-KW. MAXIMUM DEMAND, GENERAL SERVICE

The rates of the water-power cities, Minneapolis and Baltimore, are higher than several primarily steam-power cities.

30,000 Kw.-Hr. per Month			100,000 Kw.-Hr. per Month		
	Cents per Kw.-Hr.	Total Bill		Cents per Kw.-Hr.	Total Bill
Philadelphia "E"	6.70	$2010	Philadelphia "D"	3.25	$3250
Detroit	5.85	1755	New York	2.72	2720
Boston	5.71	1713	Philadelphia "E"	2.73	2730
Washington	5.20	1560	Boston	2.42	2420
Buffalo	4.95	1485	Detroit	2.39	2390
Baltimore	4.75	1425	Washington	2.20	2200
Chicago*	4.75	1425	Buffalo	2.18	2180
Minneapolis	4.55	1365	Baltimore	2.06	2060
Milwaukee	4.25	1275	Minneapolis	20.2	2020
Chicago†	4.20	1260	Chicago*	19.6	1960
Philadelphia "D"	4.00	1200	Milwaukee	1.87	1870
Cleveland	3.83	1149	Chicago†	1.81	1810
New York	3.65	1095	Cleveland	1.70	1700
Providence	2.90	870	Providence	1.43	1430
Altoona	1.50	450	Altoona	1.37	1370

*Demand charge on monthly basis. †Demand charge on yearly basis.

to direct current, a difference of about 0.45c. per kw.-hr. The steam-driven plants of Philadelphia, Cleveland and Chicago are offering electricity at a lower rate than water-power electricity is offered in Baltimore and practically equal to the Milwaukee rate, which refuses to furnish steam reserve as a guarantee of service.

The yearly load factors of the systems enumerated including the traction service are as follows: Chicago, 43.6

per cent.; New York, 35.7; Philadelphia, 36.8; Boston, 34; Brooklyn, 35.6; St. Louis, 42; Detroit, 43.

At a traction load factor of 35 per cent., approximately the factor for the whole system, electricity for traction in amount equal to perhaps 25 to 50 per cent. of that of the total system, is sold for less than one cent. As most of the schedules provide a somewhat less cost for an increasingly large demand, the assumption seems fair that the cost of electricity plus a profit, as delivered at substations

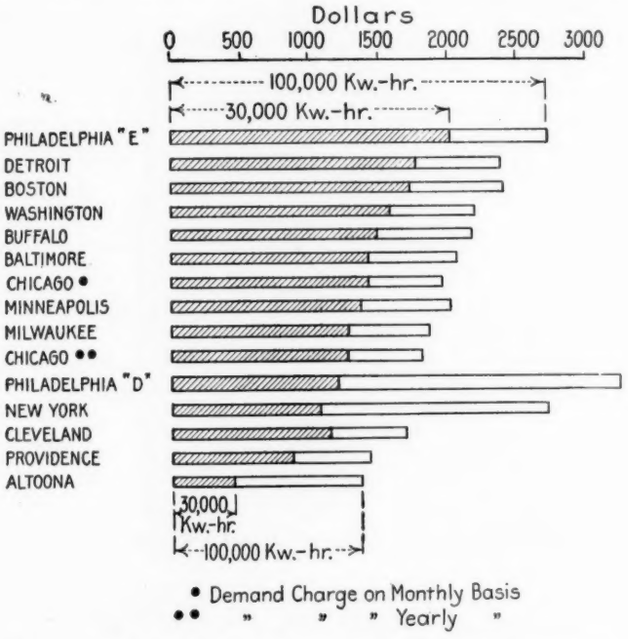


FIG. 11. MONTHLY BILLS—1000-KW. INSTALLATION, 500-KW. MAXIMUM DEMAND

in our large cities, is noticeably less than one cent, and furnishes a basis upon which to estimate the proper charges to the rest of the consumers.

The foregoing company schedules demonstrate that large steam-driven plants compete successfully for large city business with electricity furnished by water power. In fact, many city companies receiving water-power energy by long-distance transmission pay as much or more than that for which steam-generated electricity is sold. Buffalo pays 0.7c., Albany 0.9c., Rochester 0.51c., and Baltimore 0.37c. per kw.-hr. for water-power electricity. In California 0.85c. is the lowest price offered for current delivered to several small cities. Colorado Springs pays 0.585c., and Winnipeg 0.875c. The Keokuk plant (Mississippi River Power Co.) delivers electricity in St. Louis at 0.6c. for a 45-per cent. load factor, or on a usual load factor around 35 per cent. at 0.78c. per kw.-hr.

The chart, Fig. 12, entitled "Contrast of Electric Rates in Ten American Cities," Graphically depicts the relation between the different schedules of each company, and of the several companies for two different load factors. While open to the criticism that a 35-per cent. load factor is never reached by residences and the low rates for traction are usually limited to not less than 30-per cent. load factor, if the schedules were all built on a definite system,

TABLE 6. HIGH-TENSION AND TRACTION RATES

High Tension 1000 Kw. Demand, Used 150 Hr. per Month	Cents per Kw.-Hr.	High-Tension Traction Service on 35 per Cent. Load Factor, 15,000 Kw. Maximum Demand	Cents per Kw.-Hr.
New York	3.26	Philadelphia	0.80
Brooklyn	2.56	Cleveland	0.81
Boston	2.00	Chicago	0.90
Baltimore	1.79	Baltimore	1.01
Washington	1.82	Boston	1.25
Chicago	1.75		
Cleveland	1.60		
Detroit	1.55		
Minneapolis	1.48		
Altoona	1.48		

the relations between them would be logically shown by this method. Full lines represent 35 per cent. annual load factor; dotted lines 20 per cent. load factor. *A* and *a* represent residence lighting; *B* and *b*, commercial lighting; *C* and *C*, 10-hp. installation; *D* and *d*, 200-kw. installation; *E* and *e*, 1000-kw. installation; *F* and *f*, 1000-kw. maximum demand, high-tension service; *G* and *g*, 15,000-kw. maximum demand, high-tension traction service.

This chart (Fig. 12) was constructed from the other comparative charts shown. Note that while the New York city rates are relatively high, the difference between the price to small and to very large consumers varies by the factor 3.2, which is a little less than for Buffalo, Milwaukee, Detroit, Chicago and Altoona. On the other hand, the high rate to small consumers in Philadelphia is accompanied by the lowest rate to the big interests, with a factor of 11.9. Boston and Cleveland show the small consumer

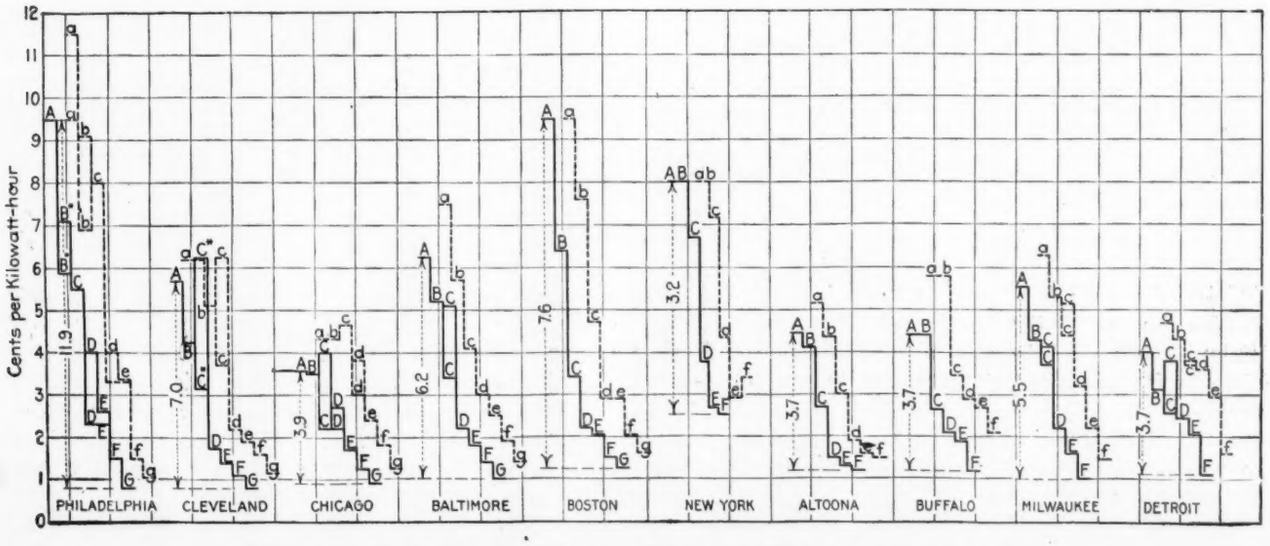


FIG. 12. CONTRAST OF ELECTRIC RATES IN TEN AMERICAN CITIES

paying 7.6 and 7 times, respectively, more than the big consumers.

Apparently, a fairly well-designed set of schedules for a good load factor should show a charge to the small consumer not over four times that to the largest consumer, and it is highly probable that a really correct system of rates would show nearly 3 as the ratio.

In general, this study of electric rates in force in the principal Northern and Eastern cities would indicate:

1. That steam-driven plants are on a favorable basis as compared with water-power plants.
2. That all costs, including some profit, of generating and delivering energy to the substations is less than 1c., probably 0.8 to 0.9c., per kw.-hr.
3. That the bulk of the schedules are based on the principle of the number of hours' use of the demand—either the Hopkinson or the Wright systems.
4. That most of the companies depart from the demand system by providing "quantity only" rates, taking no cognizance of the load connected. Such rates are usually rather low.
5. That the schedules providing for a ratio of 4 or less between charges to small and large consumers are enabling companies to make ample profits and therefore ratios of 6 or more are open to just attack.
6. The far Western cities have more equitable rates and are generally lower to the great bulk of consumers than the Eastern cities.

Purging Ammonia Condensers

By G. A. Robertson

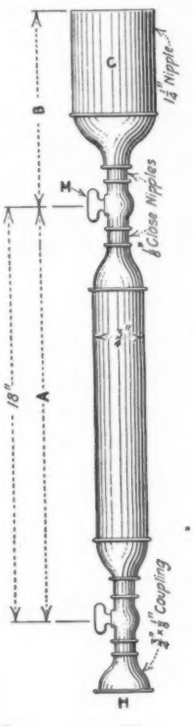
It sometimes becomes necessary, during the season's run, to purge the ammonia condensers of air or foreign gases that have accumulated. The presence of either in the condenser is indicated by a rise in the head pressure. High head pressure, however, does not always mean that there is air in the condensers, consequently care should be exercised in purging, so as not to blow away ammonia in an effort to lower the pressure. Many an engineer has lost his position by purging the condensers too freely, when the excessive pressure was due to causes other than the presence of air.

Provisions for Purging

The usual method of purging is to have one stand, called an air stand, higher than the others. The bottom pipe of this air stand is connected, usually by ¾-in. pipe, to the pump-out line of the other stands, and also to the liquid header. The return-bend end of the bottom pipe is provided with a ½-in. outlet, which is connected to the bottom of the ammonia receiver. In this line is installed a check valve to prevent liquid ammonia from passing from the receiver to the air stand. It is well to have this end of the air stand lower by at least 2 in. than the inlet end. Frequently, all of the return bends on this end are tapped and connected to a common header in order to drain each pipe of liquid. The top pipe, at the high end, is provided with a ½-in. purge valve. A pipe is run from this valve into a bucket of water, the loose end of the pipe being submerged three or four inches. By cracking the purge valve a small flow of the gases is allowed into the bucket of water. The water absorbs the ammonia and the foreign gases come to the surface in bubbles. While purging, a small quantity of water is run over the air stand. It is claimed that the upward flow of the gases into the stand, brought about by the condensation of the ammonia gas, entraps the air in the top pipes of the stand, and is thus led off through the purge valve. It is well to install a ½-in. tee with the purge valve at some low point on the air-stand connections, as this will permit purging of air that has found its way to the lowest point, especially if the air stand is shut off and allowed to cool. Air, being heavier than ammonia gas, will by gravity seek the lowest point.

Easy to Waste Ammonia

The amount of ammonia passing through the purge valve depends, of course, on the amount of air in the stand and the amount the purge valve is opened. The latter will depend largely upon the experience of the operator. It is easy to blow away a lot of ammonia, while on the other hand a lot of coal can be wasted, owing to high pressure, because the engineer is afraid of wasting ammonia by purging.



Indicator Vessel

The apparatus shown in the sketch will be found handy in purging, since it shows in a rough way the percentage of ammonia passing through the purge valve. It is made of standard pipe and fittings. The volume of the pipe and fittings between the pet-cocks indicated by *A* is equal to the volume indicated by *B*. This can be determined by filling space *A* with water, and cutting nipple *C* to such a length as to hold this amount.

To operate the apparatus, connect the end *H*, by hose or pipe, to the purge valve with the end *C* lower than the end *H*. Have the pet-cocks open. Open the purge valve about one turn and leave it open for a few seconds to free the apparatus of air. Then with the valve still a quarter turn open, which should give a reasonably good flow of gas through the apparatus, close the pet-cocks. Immediately disconnect the instrument and hold it in a vertical position with the end *C* up. Fill the 1¼-in. nipple *C* with distilled water, and slowly open the pet-cock *M* until the water in *C* begins to fall. All the ammonia gas between the pet-cocks will be absorbed by the water, leaving the foreign gases. The quantity of water, by volume, that passes from *C* into the space *A*, will represent the volume of ammonia contained in the sample. The foreign gases will be trapped between the water in the ¾-in. pipe and the nipple *C*. Thus, in a rough way one can guard against the loss of any great amount of ammonia by purging, and still be able to purge air from the system.

New Byproduct Coke Ovens in England—The Ebbw Vale Steel, Iron & Coal Co. in England has a modern plant for the production of coke and the recovery of byproducts which have hitherto been largely neglected. It is expected to produce an excess of 9000 cu.ft. of gas per long ton of coal, from 5 to 6 gal. of tar, 20 lb. of sulphate of ammonia and from 1700 to 1800 lb. of coke. Further extensions of the plant will be made to recover benzol and toluol.—"Coal Trade Bulletin."

Some Popular Misconceptions Concerning Condensers

By F. R. Low

SYNOPSIS—The rate of air leakage being the same, would the air pump of a condenser do more work when the vacuum was 29.5 in. than when it was 28 in.? Without thinking one would say "Yes," but it does not. The work of the air pump is the same in both cases. When the absolute pressure in the condenser is 2 in. of mercury and the barometer 30 in., what is the ratio of compression in the air pump? Not 30 ÷ 2 = 15 by a long way.

A surface condenser fitted with an air pump of the hydraulic type maintains a vacuum of 29.5 in. with hurling water of 40 deg. The temperature of the hurling water goes up to 97 deg. and the vacuum falls to 28 in. In which case is the air pump doing the more work?

Almost anybody who had not thought it out would say that it was doing less work with the lower vacuum, because it is pumping the contents out against a less difference in pressure; but let us see.

The pressure in the air pump is the sum of the pressures exerted by the air and by the water vapor. The pressure exerted by the water vapor is that due to the temperature of the hurling water, which at 40 deg. is 0.25 in. of mercury. With a 30-in. barometer the total pressure in the air pump when the vacuum is 29.5 in. will be 0.5 in. of mercury. Since 0.25 in. of this pressure is furnished by the vapor, the other 0.25 must be furnished by the air; that is, there is air enough present to exert 0.25 in. of pressure.

When the temperature of the hurling water goes up to 97 deg. the vacuum falls to 28 in.; i.e., there is a total pressure in the air pump then of 2 in. The pressure corresponding to 97 deg. is 1.75 in.; hence there must be, just as there was before, enough air present to exert 2 — 1.75 = 0.25-in. pressure.

The air pump has to eject, therefore, just as much air as it did before, and it has to compress it from the same pressure, 0.25 in., that it did before to the same atmospheric pressure. It has, therefore, the same amount of work to do in each case.

It is unnecessary to compress the water vapor because there must always be enough present to saturate the space occupied by the air, the excess being condensed by the hurling water as this space is reduced by compression of the air.

The Ratio of Compression

It is evident from the foregoing that the ratio of compression is greater than would have been thought. One naturally thinks, when the pressure in a condenser is 2 in. and the contents must be compressed to atmospheric pressure, say 30 in., that the ratio of compression will be about 30 ÷ 2 = 15. But if it is only the air which is compressed, and that air is at an initial pressure of but 0.25 in., the ratio of compression is, roundly, 30 ÷ 0.25 = 120; which means some difference in the displacement or capacity of the air pump.

The great increase in air-pump capacity necessary to maintain a constant vacuum with increasing temperatures of hurling water is shown in Table I, conditioned for maintaining an absolute pressure in the condenser of 2 in. of mercury. At 40 deg. the vapor pressure is 0.25, leaving 2 — 0.25 = 1.75 in. of pressure to be exerted by the air. At 59 deg. the vapor pressure is 0.50, leaving 2 — 0.50 = 1.50 in. to be exerted by the air. As the leakage or intake of air is assumed to be constant, the same weight must be pumped out per second. But at 1.5 in. pressure its volume per pound would be $\frac{1.75}{1.50}$, or 1.167 times what it would be at the 1.75-lb. temperature corresponding with the lower hurling water, with an increase in the relative sizes of air pump required as indicated by the last column corresponding to the increasing temperature of hurling water indicated in the first column.

TABLE I

Hurling-Water, Temperature, Deg. F.	Corresponding Vapor Pressure, in Mercury	Pressure Exerted by Air, in Mercury	Relative Air Volumes
40	0.25	1.75	1.00
59	0.50	1.50	1.16
70	0.75	1.25	1.40
79	1.00	1.00	1.75
86	1.25	0.75	2.33
92	1.50	0.50	3.50
97	1.75	0.25	7.00

Water Temperature and Air-Pump Capacity

In view of the foregoing one would naturally conclude that less air-pump capacity would be required in winter than in summer. Quite true, if one is content to get along with a summer vacuum when the colder water of winter is available. But suppose you want to get the best vacuum possible with the cooling water obtainable?

Take a surface condenser with cooling surface enough to maintain a vacuum corresponding to a total heat head of 22 deg., that is, a difference of 22 deg. between the temperature of the inlet circulating water and the temperature on the steam side of the tubes. We can assume for this discussion that the economic thermal performance of the condenser will remain constant, i.e., that the same total heat head will be maintained irrespective of the temperature of the circulating water; therefore, the temperature corresponding to the vacuum may be obtained in every case by adding 22 deg. to the temperature of the inlet circulating water.

Then for the temperatures of circulating water given in the first column of Table II the temperatures in the condenser would be those given in the third column, the pressures corresponding to which are given in column 4. But the lower-temperature circulating water is available for

TABLE II

Temperature Circulating Water, Deg. F.		Heat Head, Deg. F.		Vacuum Temperature, Deg. F.	Pressure Corresponding to Vacuum Temperature, in Mercury		Vapor Pressure Corresponding to Circulating-Water Temperature, in Mercury		Pressure Exerted by Air, in Mercury
40	+	22	=	62	0.56	—	0.248	=	0.312
60	+	22	=	82	1.098	—	0.522	=	0.576
70	+	22	=	92	1.5	—	0.739	=	0.761

the air pump. The vapor pressures corresponding to its several assumed temperatures are given in column 5, leaving the difference between the columns 4 and 5 (given in column 6) as the pressure which may be supplied by the air. With the 70-deg. circulating water, for instance, there is a pressure in the condenser of 1.5 in. due to vapor alone. The vapor pressure of the 70-deg. water with which the pump can be supplied is 0.739 in. (column 5). There can, therefore, be 1.5 — 0.739 = 0.761 in. air pressure in the air pump, which must have displacement enough to discharge it at that density as fast as it comes in. With the 40-deg. water the vapor pressure in the condenser would be only 0.56 in., so that a much higher vacuum is possible, but figuring the same way as before, the air when the pump takes it will be at only 0.312-in. pressure, which means $\frac{0.761}{0.312} \times \frac{460 + 40}{460 + 70} = 2.3$ times the volume and air-pump capacity with 0.56-in. absolute pressure and 40-deg. water as with 1.5-in. absolute pressure and 70-deg. water.

The water-jet pump, which is virtually confined to one speed and therefore inflexible with regard to capacity, should be provided large enough to take care of the maximum air leakage and to handle the normal amount of air in the attenuated form which it takes at the high vacuum attainable with winter cooling water.

Efficiency of Heat Engines

By R. L. Wales*

SYNOPSIS—The limitations of and differences between the Carnot, Rankine and actual steam-engine efficiencies.

In a certain engineering periodical there recently appeared a request to compare the relative thermal efficiencies of two steam engines—one using steam at 100 lb. absolute and exhausting at atmospheric pressure, the other using steam at 150 lb. absolute and exhausting into a condenser at 26-in. vacuum. In answer to this request the efficiency of each engine was worked out by finding the absolute temperatures, T_1 and T_2, corresponding to initial and exhaust pressures respectively, and substituting in the formula

$$Efficiency = \frac{T_1 - T_2}{T_1}$$

While the above formula is commonly applied in this way, it is wrongly applied, as will be explained.

By "efficiency" is meant, in general, the ratio of output to input. If, in a certain hydraulic plant, the headrace is 30 ft. above the tailrace, then every pound of water in falling from the higher to the lower level develops 30 ft.-lb. of work. If only half this drop is utilized, as by filling a bucket at the top and dumping it half way down or by filling it half-way down and dumping it at the bottom, it is evident that from each pound of water only half the available work would be obtained. The output would be half the input, or the efficiency would be 50 per cent. If three-quarters of the fall were utilized, then the efficiency would be 75 per cent., etc. In general, if the total height of the fall were H_1 and the water were dumped at height H_2, or used over range $H_1 - H_2$, the efficiency would be represented by $\frac{H_1 - H_2}{H_1}$.

Now, just as water must move from a higher to a lower level in order to develop work, "heat quantity," which may be considered as analogous to mass of water, must move from a higher to a lower temperature in order to develop work.

In the case of the hydraulic plant it is evident that for maximum efficiency all the water must be taken in at the highest possible level and dumped at the lowest possible level. A similar condition is true for a machine which transforms heat energy into work; that is, the condition for maximum efficiency is that the working substance, be it steam, air or gas, must absorb all its heat at the highest possible temperature and reject it at the lowest possible temperature.

If an engine could be devised to work on such a cycle, it would be analogous to the water plant suggested. The energy developed would depend on the ratio of the temperature range used to the total range possible. This total range would be from the initial temperature to absolute zero (460 deg. below the Fahrenheit zero), or T_1. If the lowest temperature used were T_2, then the range would be $T_1 - T_2$, and the efficiency would be $\frac{T_1 - T_2}{T_1}$, which is exactly anaiogous to the expression for the water power.

The temperature of saturated steam corresponding to 100 lb. absolute is 327 F., or 327 + 460 = 787 deg. absolute. That corresponding to atmospheric pressure is 212 F., or 212 + 460 = 672 deg. absolute. Then, the maximum possible efficiency for any engine working between 100 lb. absolute and the atmosphere would be $\frac{787 - 672}{787} = 14.6$ per cent.

The most perfect engine, then, working between these limits would waste 83.4 B.t.u. out of every 100 furnished it.

No engine ever has been, or ever will be, constructed to work on the above plan and to realize its efficiency. Many years ago an engine was suggested by Carnot, which in the imagination might operate on the cycle indicated, and its efficiency would be represented by the expression given. It was never assumed, however, that this engine could be built and operated. It was devised simply as a standard by which practical machines might be measured, and as a fundamental conception on which to develop the thermodynamic theory of heat engines in general.

For certain evident physical reasons, no practical engine can be made which will fulfill the requirements for efficiency mentioned and be free from actual losses of heat by conduction and radiation. For example, consider the case of the practical steam engine, which must include the boiler. The water does not absorb all its heat at the highest temperature, but at all temperatures intermediate between feed water and that corresponding to boiler pres-

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sure. Heat is not rejected at the lowest temperature available, but at a temperature determined by the amount of back pressure. Moreover, a considerable portion of the heat supplied to the cylinder is absorbed by the iron during the early part of the stroke and rejected during the exhaust. Add to these losses the heat radiated, and it becomes evident that if the ideal and perfect engine has its efficiency represented by $\frac{T_1 - T_2}{T_1}$, then the efficiency of the practical engine must be very much less.

Another ideal with which the practical machine is compared is the Rankine cycle, which might be considered a practical engine except that it is supposed to be made of a perfectly nonconducting material; that is, it is an ideal engine, yet approaches more nearly the practical than the Carnot. The efficiency of such an engine will be less than that of the Carnot, for the heat used will not all fall through the maximum range of temperature. The efficiency may be calculated by finding the heat supplied and the heat rejected per pound of steam used the difference being the amount of heat changed into work. The ratio of this to the heat taken from the boiler gives the efficiency. The heat per pound of steam as it enters the cylinder is $x_1r_1 + q_1$, and as it leaves is $x_2r_2 + q_2$, where x is the percentage of dry steam, r the latent heat, and q the heat of the liquid. The subscripts 1 and 2 refer to conditions at admission and exhaust respectively. It is assumed that the exhaust is condensed at back pressure and, containing q_2 B.t.u. per lb., is returned to the boiler. The heat taken up per pound in the boiler will then be the difference between the amounts when entering the boiler and when entering the engine, or $x_1r_1 + q_1 - q_2$. The value x_2 can be calculated on the assumption that no heat has been conducted by the cylinder walls; in other words, that the operation has been adiabatic. Then,

$$Efficiency = \frac{x_1r_1 + q_1 - x_2r_2 - q_2}{x_1r_1 + q_1 - q_2}$$

which is considerably less than $\frac{T_1 - T_2}{T_1}$.

To determine the thermal efficiency of the actual steam engine, data in addition to those of the initial and final conditions are necessary. Since the operations inside the cylinder are not free from heat losses and transfers, the heat changed to work per pound of steam cannot be calculated, but must be determined from a knowledge of initial and final conditions, plus a knowledge of the quantity of steam used for a given amount of work performed, or in other words, the water rate of the engine. From this can be determined how many B.t.u. are being used for a horsepower per minute. If every B.t.u. were completely transformed into work, it would require $\frac{33{,}000}{778} = 42.42$ B.t.u. per horsepower per minute, since one horsepower corresponds to 33,000 foot-pounds per minute and 1 B.t.u. corresponds to 778 foot-pounds. The efficiencies of two engines are, evidently, inversely as the number of B.t.u. used for a given amount of work; that is, if one machine uses twice as many B.t.u. as another for a given amount of work, its efficiency is only half as great. Hence we may find the efficiency of any actual engine by dividing this number, 42.42, by the actual B.t.u. chargeable to the engine per horsepower per minute. The heat chargeable to the engine per pound of steam is the difference between its content on entering the cylinder and the heat which it carries back to the boiler in the form of hot water at a temperature corresponding to back pressure. This difference, multiplied by the number of pounds used per horsepower per minute, gives the B.t.u. consumed per minute.

In order to show the discrepancy between the efficiencies of the ideal Carnot cycle, the approximate ideal Rankine cycle, and the average practical engine, working between the same temperatures, we may calculate the efficiency in each case for one of the conditions indicated at the beginning of the article, namely, dry steam at 100 lb. absolute and atmospheric exhaust.

For the Carnot

$$E = \frac{T_1 - T_2}{T_1} = \frac{787 - 672}{787} = 14.6 \textit{ per cent.}$$

For the Rankine

$$E = \frac{x_1r_1 + q_1 - x_2r_2 - q_2}{x_1r_1 + q_1 - q_2} =$$

$$\frac{1 \times 888 + 298.3 - (0.895 \times 970.4) - 180}{(1 \times 888) + 298.3 - 180} = 13.4 \textit{ per cent.}$$

For the actual engine the water rate must be known; assume it to be 30 lb. per hp.-hr.

$$B.t.u. \textit{ per hp.-min.} = \frac{30\ (x_1r_1 + q_1 - q_2)}{60} =$$

$$\frac{30\ (1 \times 888 + 298.3 - 180)}{60} = 502.6 \textit{ B.t.u.}$$

$$Efficiency = \frac{42.42}{502.6} = 8.4 \textit{ per cent.}$$

From the foregoing discussion these facts may be gathered:

1. That from the formula $\frac{T_1 - T_2}{T_1}$, the efficiency which a certain theoretical ideal engine would have if it were physically possible may be calculated, but the efficiency of the actual steam engine cannot even be approximated by its use.
2. The actual steam-engine cycle is entirely different from the Carnot and from a theoretical standpoint resembles more closely the Rankine.
3. That the actual engine falls so far short of perfection, largely through the influence of the high conductivity of the cylinder walls, that its efficiency cannot be gaged by the ideal even of its own type.
4. That while increased temperature range does from one point of view tend to increase the efficiency of the actual engine, it introduces offsetting losses whose magnitude depends on the type of the engine.
5. As a consequence, the thermal efficiency of the actual steam engine may be determined only from experimental data.

A Correction

The first two lines of the table K_3, accompanying the article on "Horsepower Constants for G. E. Type F Steam-Flow Meters," page 774, June 8 issue, read "2 in." and "0 in." These should read "12 in." and "10 in.," respectively.

Fusible Tin Boiler Plugs—The investigation of fusible tin boiler plugs has been completed at the Bureau of Standards and presented for publication. It is believed that there can now be no excuse for boiler explosions from imperfect plugs if the Bureau findings are followed, namely, to use tin to 99.9 per cent. purity and free from zinc, a requirement easily met, but which has not been the actual practice in many cases.

Nosmoke Chain-Grate Stoker

The accompanying illustrations show how the Nosmoke automatic chain-grate stoker is designed and installed. Fig. 1 shows the stoker under a water-tube boiler, Fig. 2 is a side view showing its application, and Fig. 3 shows a method of agitating the fuel bed and of relieving the ashpit of ashes where conditions demand a low setting.

Cross-walls or solid bridgings which depend upon the side wall for their support have been done away with, because the expansion of such, received by the furnace side walls, tends to crack them. This stoker is designed so that both it and the ignition arch are practically independent of the side walls for support.

The side frames of the stoker, Fig. 2, are supported on wheels so that it may be withdrawn at any time. The run of grates is supported by the lower set of rollers. Idlers are interposed between the upper and lower runs of chain for maintaining the proper distance between them, and are kept in a lateral position by piping placed loosely in bearings on the side frames. Thus the upper

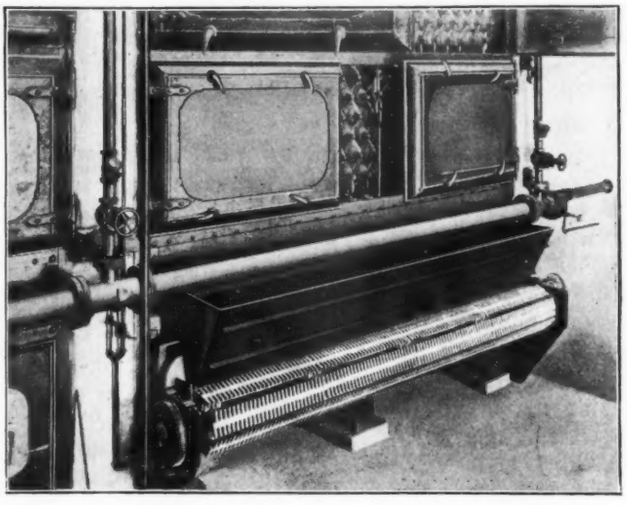


FIG. 1. FRONT VIEW OF STOKER APPLIED TO A WATER-TUBE BOILER

run of grates bears on the idlers, and these in turn bear on the lower run, which works over the lower rollers.

The driving mechanism is on the front shaft and consists of a double worm drive; that is, the worm shaft is itself driven by a worm, and this second worm is driven by a Reeves variable transmission, which may be belted to a countershaft or driven direct.

The sprockets which carry the grate chains are keyed to the front shaft. The sprockets on the rear shaft are free to turn, as is also the rear shaft itself, thus overcoming any tendency for the upper or lower run of the chain to bind. The chain is made up of clevis-like links which may be hooked together as a common hook-and-eye and which receive the grate bars. These latter are attached to the links by a heavy cotter pin that passes through an elongated hole in the web of the grate bar in such a manner that the bar may have a free upward movement the distance necessary to properly agitate the fuel bed. This agitation simply requires that there be interposed at the proper intervals inclined obstructions in the course of the upper run of grate bars, Fig. 3, and does not require extra mechanism. The method of attaching the grate bars to the chain is so simple that they may be changed while the stoker is in operation. All parts are interchangeable. The grate bars are used in multiple lengths of not over 3 ft. This reduces the tendency to warp to a minimum and still affords strength without the weight that a long grate bar would require. The grate bars intermesh, leaving openings for sufficient air

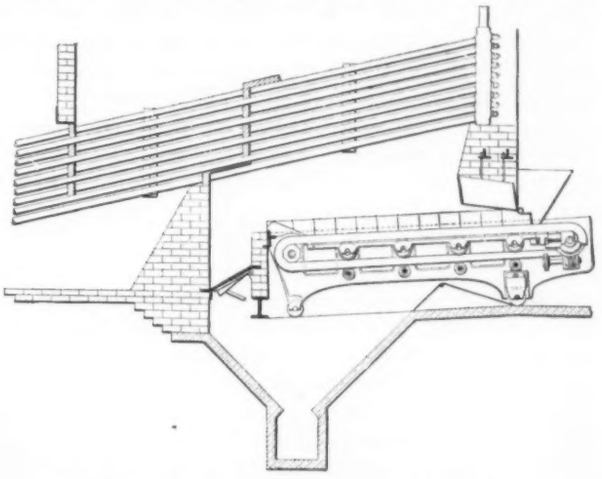


FIG. 2. SIDE VIEW OF THE STOKER

passage, but not so large that coal can pass through. They automatically clean themselves.

In stokers where the width of the firebox exceeds 7 ft., a patented device is used to support the lower rollers where the deflection due to the weight of the grates would be greatest. This prevents any breaking down of the grate surface, which is maintained in one plane.

The ignition arch presents a flat under surface and is composed of multiple arches suspended from T-beams

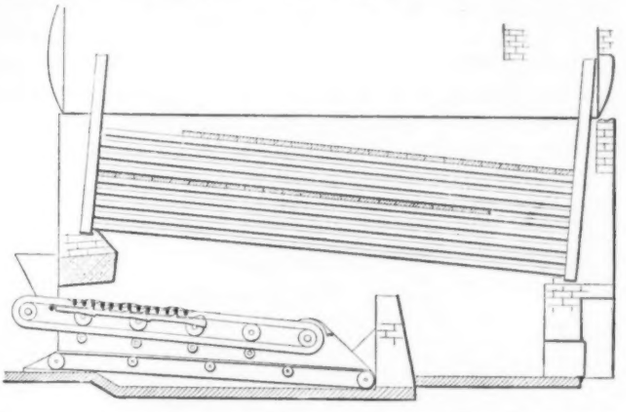


FIG. 3. AGITATION OF GRATE AND ASH CONVEYOR FOR LOW SETTINGS

supported by the side walls. These beams are free to expand and contract without affecting their supports.

The retard plates, which are air-cooled and situated at the rear of the stoker, are so designed that the fuel bed at that point is backed up to prevent the air passing any more freely through the ashes and partly consumed fuel than it does through the burning fuel at the front, where the fire is more intense.

The dumping arrangement at the rear of the stoker is so designed that no air can pass through or around it to cool off the furnace gases, and it is easily operated from the front by a lever. It may be designed to dump the ashes into the main ashpit, whence they may be removed

by hand or conveyor, or into an auxiliary ashpit and conveyor. The grate is adjustable so that the depth of feed may be regulated.

The self-contained ash conveyor shown below the stoker, Fig. 3, receives motion from the main drive and may be thrown on or off, as desired. Before dumping the ashes the conveyor is put in operation, and the fine coal which may have sifted through is first removed and shoveled back into the hopper; then the ashes are dumped and brought forward by the conveyor for removal.

This stoker, which is manufactured by the Nosmoke Stoker Co., 90 West St., New York City, may be operated by hand, should occasion arise, by removing the hopper and firing in the usual manner.

The arrangement of the arch in its relation to the grate is such that after it is heated by burning fuel on the grate, the volatiles and unseen gases being released at the point of ignition are turned into heat units before escaping from the arch, thus adding to the efficiency of the fuel and preventing the formation of smoke.

As there are different speeds in the travel of the grate, it is possible, by a combination of grate travel and draft regulation, either natural, forced or induced, to obtain various furnace conditions.

Where the natural draft is affected by atmospheric conditions, a pipe filled with small holes is placed between the revolving grates, immediately under the point of ignition, and to this pipe a blower is attached. This is used when required to emphasize the ignition or to give the right mixture of oxygen.

Repairing Flame Bridges in B. & W. Boilers

By R. A. Brownell

In the Babcock & Wilcox type of boiler the groups of tubes are divided into three distinct parts by what are known as the baffles, or flame bridges, the function of which is to form the passage for the gases from the furnace to the flue. They are made up of flame plates and tube brick. The plates are of cast iron about ⅜ in. thick and are designed to close the space between the tubes when put in at about right angles to each other. The tube brick fit between the tubes and protect the flame plates, which in turn act as a backing for the tube brick.

In replacing a flame bridge, it is first necessary to remove the old tube brick, breaking or prying them from the flame plates and giving them a quarter turn so that they will drop down the diagonal space between the tubes.

The bolts securing the flame plates at top and bottom should then be removed, the plates given a quarter turn and taken out.

There are two sets of flame plates, one placed diagonally in one direction and the other diagonally in the opposite direction, crossing each other and bolted together at the top and bottom.

Fig. 1 shows the manner of placing the plates from either the top tubes, furnace or combustion chamber. It is necessary to put in all the plates that run in one diagonal direction before any of those in the other direction are placed. This is done by inserting the plate in the diagonal space between the tubes, first in position *X*, then turning to position *Y*, and finally to *Z*, and when its proper location is reached and both sets are in place they fill the space between the tubes, after which they should be secured with bolts at the top and bottom.

Three tools are necessary for putting in the tube brick. One tool *A* is made of a 1¼-in. square bar 6 or 8 ft. long, with a yoke secured to it 10 in. from the end. The second tool *B* is made of 1¼-in. square bar with two pieces of 1-in. steel bent and secured to it about 12 in. apart. The third tool is a pair of tongs of a special design, used to handle the tube brick.

Fig. 2 shows tool *A* with the yoke, which is placed between the tubes, and brought into position by twisting the end of the bar with a wrench. This spreads two tubes in a horizontal direction.

Tool *B*, as already described, is inserted directly behind tool *A* and can be either twisted into position or inserted at an acute angle to the tubes, then pulled to a position at right angles to them. This spreads the two tubes acted upon by tool *A*, but in a direction at right angles to it, making a space large enough to insert the firebrick. These two tools are placed about two feet from the flame plates.

In placing the tube brick the tongs are used as shown at *C*, Fig. 2. They are fastened to the tube brick, inserted between bar *B* and the flame plates, raised or lowered as the case may be, in the diagonal space between the tubes. The brick is then given a quarter turn. It is then knocked into position against the flame plates with the tongs. These operations are necessary in the placing of each tube brick, and if the tubes are fairly straight the bricks can be put in place readily. Fig. 3 shows details of the construction of the tools required which may be easily made by a blacksmith.

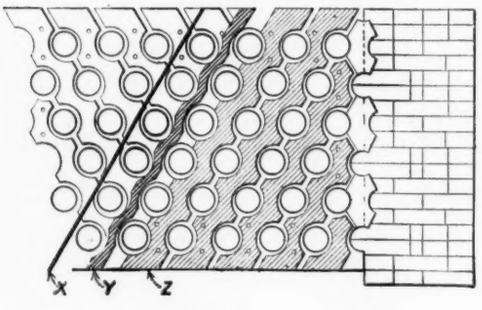


Fig. 1. Placing Flame Plates

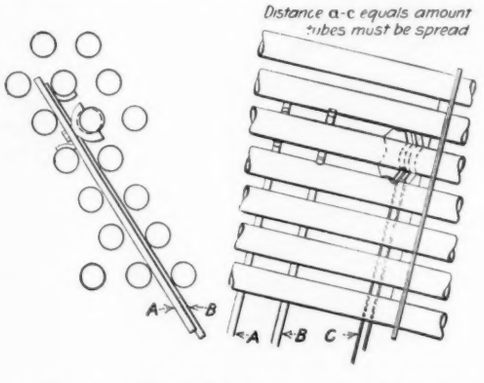


Fig. 2. Tube Spreaders and Tongues

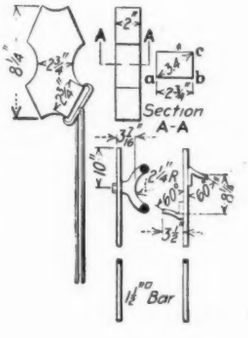


Fig. 3. Details

Editorials

Boiler Laws in Minnesota

The placid peace of the prairie is disturbed. Minnesota, which has a sort of monstrosity boiler law, has an inspector for Winona county who, the local engineers claim, does not meet the requirements of the law, which states that inspectors must be qualified in the construction of steam boilers and have had at least ten years' experience in operating steam engines and boilers. The local engineers are wrought up because the only qualification they can apparently find in this inspector is that he has had forty years' experience with threshing engines.

Now, nearly a half-century rounded out at the throttle and furnace door of a thresher is a record commanding the respect even of a summer boarder. It is an experience any man may well be proud of. This venerable farmer should know as much about threshing as Steinmetz does about electricity. But to qualify for a boiler inspector's job a whole century of experience running threshing engines would be inadequate. The required knowledge of steel plate, efficiencies of riveted joints, patches, safety-valve problems; the development of the sharp sight that sees defects invisible to any but long-trained eyes; the possession of the ear that immediately knows when the sound of a hammer blow does not sound right and why—these cannot come from running a threshing machine, however, admirable, painstaking and willing the runner may be.

Aristotle once told Alexander that there was no royal road to mathematics. There is no short cut to boiler inspection by way of the reward-for-political-service route.

The Winona affair should be the least of the Minnesota citizens' worries. It is of far greater importance that they concentrate their efforts on getting a whole new boiler law than a new inspector for Winona county. The law as it stands is a political appurtenance in the governor's hands. He appoints an inspector in each senatorial district. There is no recognized chief inspector. The inspectors report individually to the secretary of state. They inspect boilers, hulls and equipments of vessels; examine and license engineers, firemen and masters and pilots of vessels. They keep the substantial fees, all of them, as their compensation.

Who will doubt that Minnesota would be more safe from boiler accidents, would conduct inspections more efficiently, and even put funds, above expenses, into the treasury if she had a new law conforming with the widely adopted code of the American Society of Mechanical Engineers and similar to the laws and procedure in Massachusetts, Ohio, Wisconsin and Indiana? The public would be as safe as it is possible to make it; boiler owners and users would be more certain of thorough inspections; the engineers would be content to recognize the rulings of superior inspectors; boiler builders would be more assured, because of the wider uniformity in requirements; and there would be a minimum of political influence and intrigue.

Here is a field for the efforts of the engineers of Minnesota who have the interest of the state at heart. Here is a way to do a thousand times more lasting good for themselves and the citizens than by ousting a venerable farmer who merely takes advantage of an opportunity put in his way by the governor and the law, which, at least, was acquiesced in by the people.

⌘

Comparative Electric Rates

Much food for study is afforded by the charts, produced elsewhere in this issue, showing a comparison of the electric rates for light and power in a number of the larger American cities. While space limitations prevent inclusions of the complete rate schedule of each company, the examples selected are typical and cover a range from the small residence to the large traction load. Far greater discrepancy seems to exist between the rates of the different companies in the case of the small consumer than with the large consumer; moreover, the Middle Western cities appear to have more equitable rates than those in the East. The rates of the steam-driven plants, with one or two exceptions, compare favorably with those employing water power. This may be due either to the hydro-electric rates being brought up to steam standards, or to the necessity of providing steam stand-by plants.

Significant is the showing of the New York City rates, as disclosed by the final chart. Since the recent reduction by order of the Public Service Commission, these rates compare favorably with those in many of the other cities and are decidedly better than those of Boston or Philadelphia. While the maximum is still high, the ratio between the maximum and minimum is the lowest of any of the cities mentioned.

⌘

St. Louis Active in Rate Case

When the great hydro-electric plant at Keokuk was put in service about two years ago, the people of St. Louis had high hopes of benefitting by cheap power. Through devious rate manipulation, however, their expectations have not been realized, and a few months ago, through the Engineers' Incitation Club, they presented their grievances to the Missouri Public Service Commission. That body has now ordered an audit and appraisal of the property of the Union Electric Light & Power Co., in St. Louis, to determine what shall be considered reasonable rates to be charged by that company.

It appears that the present rates have been fixed by steam-plant standards, and that an intermediary company, between the producing and the distributing companies, helped to annul the effect of the low price paid the hydro-electric company. Whether collusion is thereby involved will undoubtedly be brought out by the proceedings. The maximum rate to small consumers is ten cents per kilowatt-hour, and the minimum rate to large consumers approximately one cent per kilowatt-hour; the average gross revenue being in the neighborhood of two and

one-quarter cents per kilowatt-hour. This, it is charged, shows discrimination against the small consumer.

The local press and others have long urged the installation of a municipal plant having a capacity equal to about one-quarter of the city's demand, and, by acquiring the underground conduits to which the city now has a right, forcing the hand of the central station. The municipal plant of Cleveland, selling current at a maximum of three cents per kilowatt-hour, Toronto, selling at the same price, and Winnipeg, for a trifle more, are cited as illuminating examples. There are now over 1500 municipal plants in the United States and about 200 in Canada. The numbers have doubled within the past 10 years, and this growth alone is a favorable indication. While it is true that some have been failures, because of hasty action before conditions were thoroughly investigated or of mismanagement after the plant had been installed, still others have been a decided success and have effected a large reduction in rates.

Not long ago, at an election in St. Louis, twenty-eight out of twenty-nine aldermen elected had previously indorsed the municipal-plant movement. The Missouri Public Service Commission, by decisions in previous cases of rate discrimination, has gained a reputation for judicial fairness, and it is reasonable to assume that the present case will be handled in a similar manner. However, should the city fail to obtain redress by these means, the municipal-plant project would be an excellent club with which to force concessions from the central station.

For the Citizens of New York

Saskatchewan, Canada, is mostly a thinly settled prairie land. But she thinks enough of her citizens and they enough of themselves to maintain a good boiler department that inspects and approves specifications.

The great Empire State is a place of intense industry. It had factories and great cities before Saskatchewan was inhabited by white men. What the New York law says about boiler inspections and specifications you could write on your thumb nail.

And yet New York thinks she is a leader in the "safety-first" movement.

The Steam Boiler Act of Saskatchewan requires that the boiler department be notified of a boiler explosion at once by telegraph. New York does not care how many boilers are blown up; and she does not give a rap whether she is notified by wire, or pack mule, or not at all.

Here is just a little bit of advice that the boiler department of Saskatchewan gives to its citizens: "When buying a new boiler you should receive from the manufacturer or agent an affidavit stating that the boiler is built in accordance with a design and specifications registered with the department, and that all the material used in its construction are of the quality required by the provincial regulations."

You never received anything like that from any department of the great Empire State, did you?

In Saskatchewan an owner who allows his boiler to be operated without a steam gage is liable to prosecution, and the engineer who operates it is liable to the cancellation of his certificate.

Now it is totally different in New York State. There is no law that says you shall not carry any pressure you like on any old junk boiler. And the great Empire State is not interested enough in you to care whether or not you have a steam gage, or a safety valve, or a fusible plug in that junk thing.

O yes, the factory inspector's office will command you to make needed repairs when a certificate of inspection shows the boiler to be dangerous!

But don't you see the mistake? The law permits you to *wait* until the thing *is* dangerous.

You citizens of New York, looked up to as leaders in thought and work, how long are you going to let your state drift along without a good boiler law? Massachusetts, Ohio, Wisconsin, Indiana, Montana and Colorado have excellent boiler laws and are making them better by adopting the A. S. M. E. code. California, Illinois, Michigan and Pennsylvania give promise of soon having such laws. Can you think of any good reason why New York should not be on the list?

A Good Start, We Hope

Anyhow, Michael Fogarty, of the Committee on Industrial Interests and Relations of the New York Constitutional Convention, wants that state to have a boiler law. He has introduced an amendment to the Constitution providing for a boiler-inspection department.

A Constitution is a place for fundamentals, and very likely Mr. Fogarty's amendment will be killed. But New York needs a boiler department sufficiently to warrant getting it by way of the Constitution if legislative means prove futile.

Progress with Bleeder Turbines

That the bleeder-type turbine may be operated economically while holding the pressure steady on a heating system is the conclusion reached by F. W. Laas, of the Iowa Railway & Light Company, Cedar Rapids, in a paper abstracted on another page. To obtain these results, special consideration should be given to selecting the proper size and range of both electrical and heating equipment and to their control under varying conditions. In general, the electrical load should overbalance the heating load, a matter deserving closer attention by the commercial departments of operating companies. The paper relates some interesting operating experience with this type of apparatus.

A Tribute to the Engineer

In the June issue of *Cotton,* a paper devoted to the cotton and textile trade, a writer gives the engineers a boost in claiming that they are capable of giving good advice to owners, superintendents, etc., when it comes time to purchase new or additional apparatus. We believe the writer is about right. He says:

> If your power-plant engineer is a capable fellow, he will be able to give you some good ideas along the economizing line. These engineers usually know more about such things than they are given credit for. If your engineer is a student of engineering he will, therefore, hit the mark pretty close.

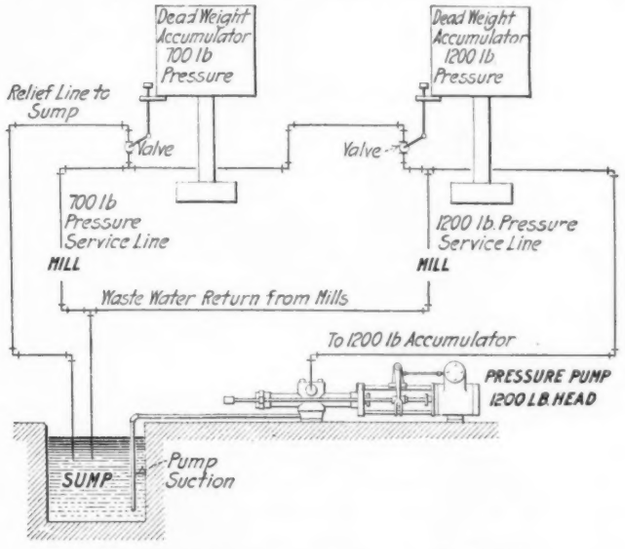
Now, when the problem is "put up to you" are you going to be able to give the necessary advice? It pays to keep a little in advance of your plant all the time and, when the opportunity does offer and the owner or manager comes to you for suggestions on improving the equipment, be prepared to show what is needed and why.

Correspondence

Two-Pressure Hydraulic Service

I read with interest the article in the issue of May 18, page 671, by A. D. Williams on two-pressure hydraulic service. It is to be regretted, however, that the article was not more complete in detail, for there are some important points that are not clear. For example, it is shown that the first two connections in the line from the pump are the high-pressure accumulator and the high-pressure service line. Up to this point the line has a 1200-lb. head, and when the accumulator is full it opens the valve and a portion of the water flows to the low-pressure line.

It would be interesting to know what form of valve this is that will maintain a 1200-lb. head on one side and a 700-lb. head on the other, especially when the



ARRANGEMENT OF ACCUMULATOR PIPING

accumulators are at the full height; also, why there should be surplus water when the accumulators shut the pumps down. In a word, how can there be a line supplied from one source, with a 1200-lb. head in one part, a 700-lb. head in another, with an open though restricted end.

The high-pressure accumulator, when full, will permit the water to pass on to the low-pressure accumulator, which, when full, will stop the pump. The water can still pass over to the low-pressure line, which will raise the accumulator until the relief valve is opened. This would continue until the pumps were started again, which in effect is that the pumps are kept going continuously and the relief valve is a necessary precaution to prevent the low-pressure accumulator from running over. In this system it would seem that there is a considerable waste necessary to maintain a balance.

Another noticeable point is the use of a crank and flywheel pump. It is ordinarily held that these are unreliable on account of their liability to get stuck at dead points unless they are kept up to a certain speed. The ratio between the steam and the water cylinder in these pumps is remarkable, in that the steam ends seem much too small for the work required of them. This, however, is a matter of steam pressure, but allowing 150 lb. gage pressure, the total mean effective pressure would be only about 16 per cent. in excess of the static head due to 1200 lb. per sq.in. on the water piston. At this steam pressure the total mean effective pressure on the steam piston is actually less than the total pressure on the plunger in the duplex pumps.

These systems of hydraulic-pressure installations are important in rubber manufactories, and the arrangement shown by Mr. Williams possesses many desirable features. In fact, the two-pressure system is considered a necessity. There are places where pressure-reducing valves are used, but they are not as reliable as the dead-weight accumulator.

In some places where the accumulator capacity is small a third pressure is used for quickly raising the presses to their position. This pressure is about 250 lb. It is sometimes directly connected, but it works better through a tank having an air cushion as this avoids shock and water hammer.

WILLIAM HIRST.

Trenton, N. J.

Eliminating Power-Plant Noises

Upon taking charge of a plant, my predecessor informed me that a certain alternator should always be run at night, pulling the heavy load, while the other (an exact duplicate) should always be run during the day, pulling the lighter load. The reason for this, he informed me, was the peculiar relation, in regard to position, the noisy alternater had to the switchboard; that it was impossible to stand the howling of the machine when heavily loaded. I had heard of switchboards acting as sounding boards, throwing the sounds to different parts of the plant, but never as being the primary cause of noise. I found that one machine did make a great deal more noise than the other on the same load, so examined the noisy one carefully and found the air gap between rotor and stator anything but balanced. On one side there was a $\frac{1}{4}$-in. gap, while on the other side there was hardly $\frac{1}{16}$ in. After equalizing, the excessive noise disappeared, although the alternator and switchboard were still doing business at the same old stand.

Another source of disagreeable noise was the boiler-feed pump for six 300-hp. boilers, the feed line running directly under the floor of the boiler room. When the pump was working fast the line would jump and make a noise at every stroke, causing the floor to vibrate. Looking this pump and feed line over, one thing that struck me forcibly was the absence of an air chamber on either

the pump or the pipe line. Having no overhead room for an air chamber, I was in rather a bad position, but decided that one was necessary. I had a large hole cut in the floor directly over the feed line, about one foot from the pump. I found a piece of extra heavy 12-in. pipe about six feet long, capped at both ends and tapped on one end for 2-in. and the other for ¾-in. pipe. The 2-in. end I connected to the feed line and an air line to the ¾-in. hole above. A little cement around the chamber and paint on the part above the floor finished the job. When we started the pump the noise was gone, and a lead pencil will stand upright on the water end of the pump.

EDWARD O. EDNEY.

Birmingham, Ala.

Machining a Piston Ring

The article by G. Strom on page 353 of the Mar. 9 issue of POWER is interesting in showing a novel method of machining piston rings.

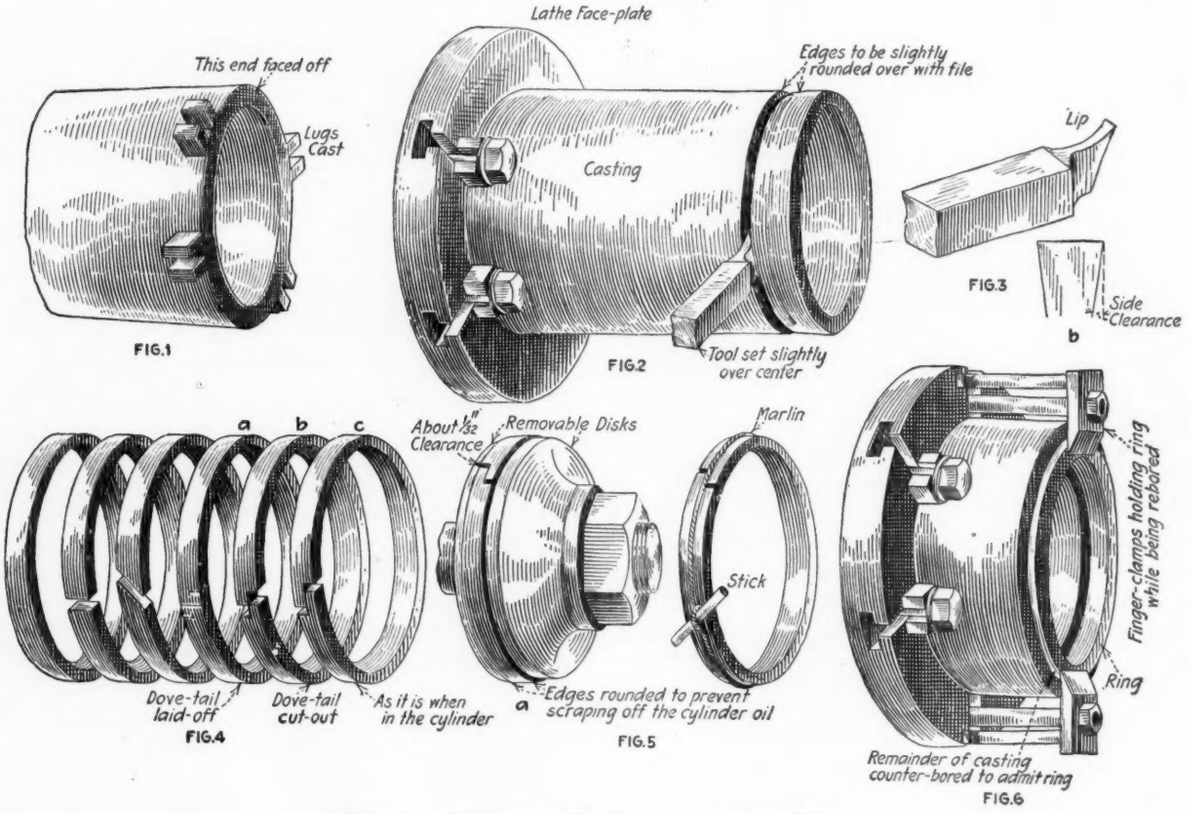
My observation is that when a ring is turned to fit, with no allowance for circular expansion, it will score the cylinder or itself and will be more or less distorted owing to the unevenness of the grain throughout the ring. Although the ring is made of the same material as the cylinder and should expand at the same rate, it must be remembered that the cylinder is much thicker and requires more time to heat. Rings, depending on springs, placed between the ring and piston will score the cylinder whenever the springs are made too stiff.

Herewith is the method commonly used to produce a good-fitting ring in a minimum length of time. Beginning with a casting in the form shown in Fig. 1, for the size piston to be fitted, the operation progresses in the following order: The lug end of the casting is faced off, the casting is then bolted to the faceplate by means of the lugs ready for turning, Fig. 2. A good way to turn a casting is first to rough-face the end, then turn the outside (allowing liberal oversize for finishing after the ring is split and closed), then rough-bore the inside, allowing for finishing.

A light finishing cut should be taken off the end of the casting, to insure its being square, then a ring is cut off with tool, Fig. 3. The shape of the tool and its position are also shown. By keeping a sharp edge on the tool and feeding it slowly, the ring will be cut off square and will not need facing off. The ring may be simply split straight across, but this is rather poor practice for the reason that should the ring remain in one position relative to the cylinder a ridge will form throughout the stroke-length of the cylinder. It is quite common practice to split the ring diagonally, but it will not be perfectly tight. By splitting the ring as shown in *a, b* and *c,* Fig. 4, the foregoing faults are eliminated and it will be tight with any amount of circular clearance.

After the ring is split it is clamped between flanges on the arbor, Fig. 5, with the aid of a string and a piece of wood, as shown. This arbor may be used for rings of various sizes, the only thing necessary being suitable spare flanges. It has the great advantage that the ring, arbor and all, may be taken out of the lathe and tried in the cylinder for fit and put back in the lathe without getting out of true.

After the outside diameter of the ring is down to size, it is necessary to finish it on the inside, so as to give the ring a uniform thickness. This is done by using the re-



VARIOUS STAGES IN MACHINING PISTON RINGS

maining part of the casting, still bolted to the faceplate, by counterboring it as shown in Fig. 6 to the exact size of the cylinder and clamping the ring inside. All of the operations are made clear by reference to the various illustrations.

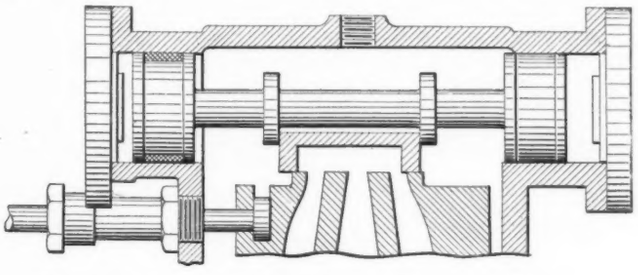
SAMUEL L. ROBINSON.

Providence, R. I.

Repairing Auxiliary Steam Valves

When the auxiliary-valve mechanism on a single pump is worn and blows through, the pressure is equalized on the two sides and the pump stops. A new valve is in order, but is not always ordered.

I have several times had good results by turning a groove nearly the full width of the bearing surface or



BABBITT METAL IN GROOVES IN PLACE OF RINGS OR SOLID PISTONS

piston, at each end, leaving only $\frac{1}{16}$ in. for a shoulder or flange, casting babbitt metal in the groove and turning it down to a neat fit in the valve chamber. Such a valve will wear a long time if the steam is dry, but water and babbitt do not go well together.

A. E. BAKER.

Cambridge, Ohio.

Mixed-Frequency Operation

An operator who owned an old type of single-phase, 133-cycle, 1000-volt, composite-wound alternator, agreed to supply a small village with water. He proposed to use the alternator for operating a 10-hp., 500-volt, 60-cycle, single-phase motor which was direct-connected to a centrifugal pump. He was alive to the necessity of reducing the voltage of the alternator, and this he did, to a certain extent, by means of the exciter. However, as the motor could not adapt itself to the extra 73 cycles, it failed to do anything except stand still and hum whenever the starter was operated. Someone advised that the trouble was due to the generator's being too small; whereupon the operator obtained a second-hand 70-hp. alternator of the same voltage and frequency ratings, but this gave no better results than the smaller machine.

An inspector was called who readjusted the engine governor to give a speed corresponding to about 75 cycles, and the voltage was adjusted to 500 volts at no load. The motor still failed to respond because the heavy lagging starting current reduced the motor-terminal voltage below the starting value. The rectifier brushes were then lifted and the rectifier short-circuited. This cut out the composite exciting field and so much improved the power factor that the motor started, ran and actually delivered water.

As the motor did not heat and as the amount of water delivered per hour was satisfactory, the operation of the 10-hp. motor by the 70-hp. alternator, was considered a success.

E. C. PARHAM.

Schenectady, N. Y.

Moisture in Furnace Air

If the following is true, and there is no doubt Professor Chandler's statement is well founded, it bears directly on the use of steam jets in a boiler furnace for producing draft.

Gayley's invention of the dry-air blast in the manufacture of iron involves a saving of $15,000,000 to $29,000,000 annually. A modern furnace consumes about 40,000 cu.ft. of air per minute. Each grain of moisture per cubic foot represents one gallon of water per hour for each 1000 cu.ft. entering per minute. In the Pittsburgh district the moisture varies from 1.3 grains in February to 5.94 grains in June, and the water per hour entering a furnace varies, accordingly, from 73 to 237 gal. In a month a furnace using natural air received 164,500 gal. of water, whereas with the dry blast it received only 25,524 gal. A conservative statement, according to Professor Chandler, is that the invention results in a 10 per cent. increase in output and a 10 per cent. saving in fuel.

LEON LEWIS.

Brooklyn, N. Y.

A Clean-Up Week for Steam Plants--Why Not?

Often nowadays, we read in the daily papers that some neighboring town or city is having its clean-up week. This movement is a fine thing and is deserving of much credit.

Cleanliness is, after all, more or less of a habit and, once acquired, is generally lasting; therefore it behooves us all to get the habit. It seems to the writer that a clean-up week for steam plants would not be a bad idea, and especially would this apply to the engine and boiler rooms of the small, one-man plant. A good coat of whitewash, clean windows and floors and a touch of paint here and there will accomplish wonders and be noticed unless the "Boss" is a blind man. Recently, I laid out a week's work along these lines for my plant, and the results have convinced me that the idea is a mighty good one and can well be applied to any small or medium-sized plant.

An excuse that some engineers use to save themselves the trouble of doing this extra work is that "the old man won't buy the needed cleaning material." I have met this objection by buying the articles out of my own pocket; then, when my employer comments upon my work (and be assured that he will), I call his attention to what I purchased. I have never failed yet to get my money back, and generally with big interest.

I have found that it pays to show that I am concerned in my employer's interests. Besides, as I have to put about half of my time in the steam plant, why not have my surroundings as comfortable and likeable as I can make them?

Monday: Cleaned tops of boilers, whitewashed settings and boiler-room walls and cleaned boiler fronts, etc.

Tuesday: Cleaned space back of boilers, gathered up all junk, etc. Cleaned up benches.

Wednesday: Listed all tools, equipment and junk in boiler room. Cleaned up and washed boiler-room floor.

Thursday: Cleaned engine-room walls, washed engine and boiler rooms and windows. Renewed glass where needed. Touched up piping with bronze where needed.

Friday: Cleaned out packing and stock closets, listed same, listed tools in plant. Touched up engines, pumps, etc., with enamel.

Saturday: Washed engine-room floor and bought two new suits of overalls. (This was to enable me to harmonize with my surroundings.)

Sunday: "Nothing to do till tomorrow."

A. D. PALMER.

Dorchester, Mass.

Peripheral Speeds

On page 815 of the June 15 issue of POWER, it is stated that 38 ft. per sec. is considered the safe limit in speed for cast-iron flywheels. Assuming it to mean rim speed, this would be 38 × 60 or 2280 ft. per min. which is entirely too low a limit. A solid cast-iron rim of thick cross-section can be safely run at 6000 ft. per min., a thick rim with well-designed joints can be run over 5000 ft. per min., and thin rims or beltwheels with bolted joints can be safely run from 3000 to 4000 ft. per min., depending on the thickness of the rim and the design of the joint.

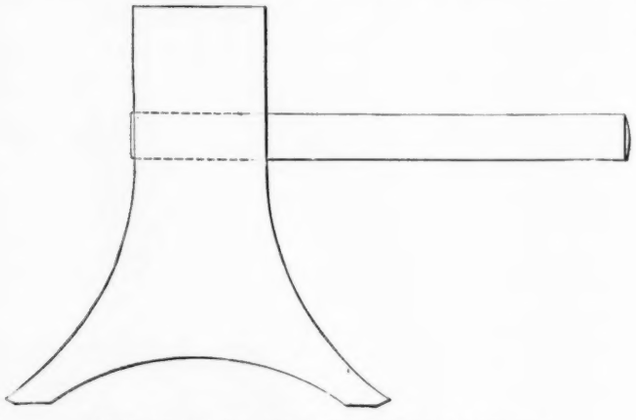
E. D. GAGNIER

Youngstown, Ohio.

[The paragraph referred to was, as indicated, taken from the report of a paper presented before the Manchester Association of Engineers by R. T. Halliwell. The speed quoted is far below the ordinary practice in this country.—EDITOR.]

Removing Fittings From Large Pipe

The following method was successfully used in removing a lot of 6- to 12-in. hot-water heating piping, which had been under ground for ten or twelve years. The



TOOL TO HOLD ON PIPE WHEN SLEDGING

cast-iron fittings were as good as new, but it seemed almost impossible to remove them without damage to the pipe and threads.

Heating was slow and hard work, so a tool was made for each size of pipe, as shown in the illustration. These tools were made heavy, weighing about five pounds each. The bottom end where it rested on the pipe was 1½ in. wide and 3 in. long for 10- and 12-in. pipe and 2 in. for the smaller sizes, and concaved to fit the given pipe. A suitable eye was provided for a handle.

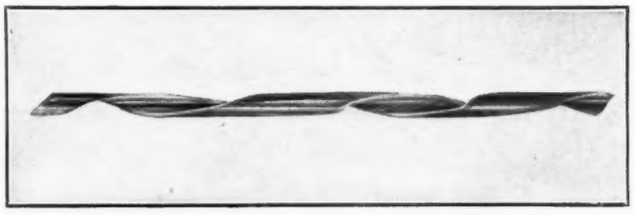
The tool was placed on the pipe close to the fitting or flange to be removed and struck with an eight-pound sledge. The pipe was turned about an inch at a time all the way around, and the fitting was usually loosened by that time. There was not more than one cracked fitting out of every one hundred, and the pipe was never damaged in the least. This, I believe, is the easiest way to remove difficult fittings without injuring them.

A. G. SOLOMON.

Chicago, Ill.

Gage-Glass Broken in a Curious Way

The photograph reproduced shows a freak way in which a gage-glass broke in the form of a spiral. The glass was $\frac{7}{16}$ in. outside diameter and 12 in. long. It was on a brine tank subjected to about 40 lb. pressure,



THE PART OF THE GAGE REMAINING

and had been in use about one year in the plant of the Solvay Process Co., Detroit, Mich. The temperature of the liquid was between 60 and 65 deg. F. The room was at normal temperature, and there was no more vibration than usual. As to why it broke as it did I venture one guess—the glass may have been blown or drawn (molded) with a twisting motion.

It has been suggested that in setting the glass in place a twisting strain may have been imparted by the packing. However, it is a wonder that the entire tube did not break, as the side that went out broke into fine pieces, leaving the spiral as shown, all in one piece.

W. H. RIBBLE.

Detroit, Mich.

Snap Rings for Dashpots

Some years ago I saw an article in POWER on the use of snap rings for repairing dashpots when they leak. At that time I had charge of a 20x48-in. old-style Corliss engine on which the dashpots worked very badly. We fixed them up with a light snap ring in each and were much pleased with the result, as they worked like new. After over six years of almost constant work, they are still going good. Later, I saw a statement by an engineer who had tried snap rings, and he claimed they failed to work satisfactorily. I would like to hear from others who have had experience along these lines.

E. F. BRUNS.

Bellville, Ill.

Electric Arc Welding*

Electric welding comprises two general processes—electric-arc welding, which is best suited to general repair work, and resistance welding, which is most applicable to manufacturing processes where many duplicate pieces of light sheet work are to be welded. For general repair work, however, where cutting, joining and building up of metals are to be done, arc welding is employed.

Direct current is used in electric-arc welding because the alternating-current arc varies from a maximum to a minimum at each reversal of the current, and hence is not suitable for welding service. The direct-current arc is practically steady, the temperature obtained is high (approximately 3500 deg. C. at the positive electrode), and the heat generated at the positive terminal is about 75 per cent. of the total heat generated in the arc.

The carbon arc is longer than the metallic arc and is, therefore, more stable and less liable to break. The metallic arc is extremely short, being only from ⅛ to ¼ in. long. After the arc is established, it can be moved about over the work by merely moving the electrode. The carbon electrode can be used to preheat the work by keeping the electrode moving rapidly enough not to melt the work.

In working with the graphite electrode there must be a potential across the arc of from 35 to 50 volts, depending on the current being used. The current varies from 200 amp. up, depending on the work. In light work, small electrodes and less than 200 amp. can be used. The average type of welding done by this method will require from 300 to 400 amp.

The metallic electrode permits much lower amperage than the carbon electrode. Currents as low as 15 amp. are used, and the upper limit is about 200 amp. The pressure at the arc is from 20 to 25 volts. The metallic electrode can be used on much lighter stock than can the carbon electrode. It requires greater ability on the part of the operator, however, on account of the shortness of the arc and the consequent difficulty of maintaining it; but this is compensated for by the fact that certain classes of welding that are possible by this method cannot be done by the others. Among these is welding overhead or on vertical surfaces. Further, there is no possibility of carbon being carried into the weld.

Cast and malleable iron can be successfully welded by the electric arc provided certain precautions are taken. For this type of welding, the work should be preheated either by the use of the carbon electrode or by means of gas, coal or oil fires. The work should be brought up to a red heat and the heat carried back from the weld, or cooling strains, and probably cracks, will follow. The work should be kept hot during the time the weld is being made.

Flux is of great assistance in welding cast iron. One commonly used consists of a mixture of borax and red oxide of iron. The borax should be heated to drive out the water of crystallization before using the flux. This mixture is supposed to prevent carbon entering the weld, and also to keep the surface of the metal in the weld clean and so permit a better union of the metal.

Metallic electrodes for welding steel or iron consist of rods from $\frac{1}{16}$ to ¼ in. in diameter and about 12 in. long. The better the material used, the better will be the weld. The carbon or graphite electrodes vary in size from ¼ to 1½ in. and more in diameter and should consist of hard, solid and uncored carbon, similar to that used in arc lamps. The end of the electrode should be rounded off, but not brought to a sharp point. The filling material used with the carbon electrode should be of the same kind and quality as that which is being welded.

Any direct-current source can be used for arc welding, but the voltage must be reduced from 10 to 50. This may be done by inserting resistance in series with the arc to absorb the excess voltage. This is plainly an inefficient method of operation, as the voltage absorbed by the rheostats is energy wasted. In order to avoid such losses low-voltage generators have been developed and a method of control, which give the maximum of efficiency, combined with flexibility and protection. The generator should be wound for a voltage of from 60 to 75. In no case is it necessary to have a generator of higher voltage than this for welding. Lower voltages may occasionally be used with extremely light currents.

*Abstract from General Electric Bulletin No. 48,904.

Cement for Steam Pipes

Cement of specially valuable properties for steam pipes and for filling up small leaks such as blow-holes in a casting, without the necessity of removing the injured pieces, is composed of 5 lb. Paris white, 5 lb. yellow ocher, 10 lb. litharge, 5 lb. red lead, and 4 lb. black oxide manganese, these various materials being mixed with great thoroughness, a small quantity of asbestos and boiled oil being afterward added.

The composition, as thus prepared, will set hard in from two to five hours, and possesses the advantage of not being subject to expansion and contraction to such an extent as to cause leakage afterward, and its efficiency in places difficult of access is of special importance.

Waste-Heat Boilers for Openhearth Furnaces*

By C. J. Bacon†

An important modern development in the steel-making industry is the use of waste-heat boilers for openhearth furnaces. [Examples of these boilers were given in our Feb. 9 issue.—Editor.] In the openhearth, or regenerative, type of furnace the heat carried away in the stack gases is used to warm the air and gas before they enter the furnace. The result is that the stack gases leave the furnace at a comparatively low temperature. In the nonregenerative type, on the other hand, the fire is at one end and the stack at the other. The flame passes over the top of the material in the furnace, and the gases go directly into the stack. In the early installations, fifty or more years ago, the waste gases from these nonregenerative furnaces were passed under crude boilers consisting of single drums or shells 5 ft. in diameter and 40 or more feet long without flues or tubes. This practice led finally to the adoption of highly developed water-tube boilers.

With the regenerative furnaces, however, little progress was made, owing to the low cost of fuel and relatively great investment required for recovering the reduced quantity of heat from the low-temperature gases. Moreover, the application of waste-heat boilers to openhearth practice is much more complicated than to the relatively simple installation with nonregenerative furnaces. Of first consideration in the use of boilers with an openhearth furnace are the requirements that the draft necessary for operating the furnace be not impaired and that the boiler equipment (with ample surface and gas passages to handle the gases efficiently) be made to fit the limited space available.

The first installation of an openhearth boiler was made in 1910 on a 65-ton furnace at the South Chicago works of the Illinois Steel Co. and was a second-hand Heine water-tube boiler with 1900 sq.ft. of heating surface. The demand of the openhearth furnaces for a draft of 1½ in. or more in the stack tube made it imperative that a fan be used between the boiler and stack, to restore the loss of draft caused by the lower gas temperature and the friction through the boiler and connecting tubes. The gases made a single pass over the heating surface, entering the bottom of the bank of 113 three-and-a-half-inch tubes near one end and passing from the top of the bank at the other end. From this boiler a gross output of 190 boiler horsepower during furnace heats, with gas at an initial temperature of 1150 deg., was obtained. About 30 boiler horsepower was required for the engine-driven fan, the exhaust from which was not recovered. Even these results demonstrated the practicability of application to openhearth furnaces without detracting from the tonnage or quality of steel. They also indicated that boilers with twice this amount of surface would be none too large for furnaces making 72-ton heats.

The following year, two larger boilers were installed at the South Chicago plant. The special type of Stirling water-tube boilers selected had 4000 sq.ft. of heating surface and required relatively low headroom, thereby permitting location entirely under the charging floor. They were provided with superheaters, special baffling, induced-draft fans, economizers, and permanent soot blowers not only to favor the greater absorption of heat, but also to provide for more efficient operation and maintenance. Each boiler had three passes and was composed of 30 sections in width, each section having 13 three-and-one-quarter-inch tubes. The economizer installed was soon removed, as it did not operate satisfactorily because of excessive obstruction to the flow of gases and troublesome accumulation of dust on the irregular surface of the economizer sections. The fans, of the Sirocco type, with 72-in. wheels driven by electric motors at 400 r.p.m., provided a total draft of 4 in. of water, nearly one-half of which was required to restore the amount of draft previously furnished to the openhearth furnaces by the stack.

Following these investigations, 28 boilers were installed at another plant, where the furnaces are of 85 tons' rated

*From a paper given before the American Iron and Steel Institute.

†Steam Engineer, Illinois Steel Co., South Chicago.

capacity. As there was not sufficient room under the charging floor, Rust vertical boilers, each having 4880 sq.ft. of heating surface were used. This boiler has six drums, three above and three below, 209 four-inch vertical tubes, and the setting occupies a space 11x21x31 ft. It has three passes for the gas, and liberal cross-baffling to distribute the gases well over the heating surface. Superheaters having 346 sq.ft. of surface were placed behind the bank of tubes in the first pass, where they were protected from the high-temperature gases. In this installation the fans were driven by steam turbines. The turbine exhaust was utilized in the central heating system, so that the net cost of fan operation was only 7 boiler horsepower, or less than 2 per cent. of the gross output of the boiler. While these boilers show an average evaporation of 393 boiler horsepower during heats, 350 may be safely counted on for a year's average.

Another installation of a single boiler deserves particular mention because of the very high evaporation from a relatively small furnace of 30 tons' capacity. In all previous installations the boilers had been put under the openhearth building between the stacks, where the construction cost was considerably higher, owing to obstructions and alterations. This boiler, however, was placed entirely outside the building, and so encouraging has been its performance that steps are being taken to equip the remaining furnaces of the plant in a similar manner. The boiler, of the B. & W. cross-drum type, having 2605 sq.ft. of heating surface and 162 four-inch tubes, is divided into three vertical passes, so that the gases pass transversely across the approximately horizontal tubes, a condition favorable to a high rate of heat transmission. This boiler developed 200 hp., but a fair estimate of the average output over long periods is 170 to 175 hp., without deducting the steam required to drive the fan engine, which in this instance is a considerable amount, since there is no way of recovering the heat in the exhaust.

The weights of waste gases may be calculated on the basis that the total heat absorbed in the boilers requires a certain amount of gas to be cooled between the initial and final temperatures. Accurate direct measurement is out of the question, because of lack of suitable conditions for use of meters. This method is subject to serious error, owing to uncertainty as to the specific heat of gases at these temperatures and more particularly to the difficulty of obtaining representative temperature readings and gas analyses for determining the amount of air leakage. On account of this uncertainty, ample allowances should be made in the design of boilers, flues and fans. Air leakage has a serious effect on boiler output and should be eliminated by air-tight steel casings around boiler settings when water-tube boilers are used. Air leakage through the brick settings of water-tube boilers is a source of appreciable loss, and the most attentive efforts to keeping the setting tight by pointing the brickwork, and by application of various paints and cements have not been entirely successful.

Because of the liability of explosion in the flues and boilers, they demand constant attention, since the explosions loosen the brickwork of the boiler setting, not only increasing the air leakage, but entailing a high expense for repairs. These explosions are caused by the escape of producer gas into the flues during a reversal of the gas valves and may be reduced somewhat by close attention to the manner of reversing. The dust coming from the openhearth furnaces and checker chamber is in an exceedingly fine and adherent condition and packs closely onto the boiler tubes, as well as on baffles and projections. There appears to be no means of preventing the dust from entering the boilers, and the only remedy so far applied is frequent blowing with steam by portable and permanent soot blowers. As a rule, blowing at intervals of six hours has been found sufficient if the operation be thoroughly performed, but the dust allowed to remain has a tendency to form a scale more difficult to dislodge than that freshly deposited. In addition to blowing the tube surface while in operation, the practice is to give the boilers as thorough a cleaning as possible when out of service. The design of the boiler should be such as to prevent, as far as possible, the lodgment of dust and to facilitate rapid and easy cleaning while in, as well as out of, operation. With the advent of pulverized coal the subject of maintaining a clean boiler becomes of even greater importance, because of the large quantity of ash.

In deciding on the type and location of the boiler, the parts requiring frequent attention by the operator should be placed above the floor or where ventilation, light and cleanliness are better than under the charging floor. In many cases this eliminates all but the vertical type of boiler. The rate of heat transmission in fire-tubes is not so great as in water-tubes of the same diameter and gas velocity. Yet it is possible that the advantage of fire-tube boilers especially designed for waste-heat purposes may offset the lower rate of heat transmission. In favor of the fire-tube boiler are its simplicity, absence of air leakage, resistance to gas explosions, and relatively low cost for the same capacity.

The possible saving may be better appreciated when it is recalled that 45 per cent. of the total heat delivered to the openhearth furnace as fuel gas and combustible elements of the charge is wasted to the stack, and that one-half or two-thirds of this loss may be recovered by boilers at 60 per cent. or greater return on the investment. The heat saved is about 22 per cent. of the heat in the coal charged to the producer, or about 1,600,000 to 2,200,000 B.t.u. per ton of ingots. In terms of coal containing about 11,000 B.t.u., this is equivalent to an average of 180 lb. per ton of ingots. But this heat is in the form of steam which, generated in coal-fired boilers at 60 to 70 per cent. efficiency, would require 250 to 300 lb. of coal. If the openhearth fuel were natural gas, the boilers would generate about 85 per cent. as much steam as with coal, owing to less weight of products of combustion. Pittsburgh coal gives about 25 per cent. more waste gases per pound than ordinary coal, but on account of less coal consumed per ton of ingots, only slightly more steam would be generated.

The savings herein pointed out represent a marked economy in openhearth practice, but there is still an opportunity for improvement in new installations by means of larger boilers and more attention to reducing the heat losses resulting from air leakage and radiation in the regenerative chambers, valves and flues. The minimum performance striven for should be a reduction of the gas temperature from 1200 deg. at the inlet to 500 at the outlet. In present practice outlet temperatures, neglecting the cooling effect of air leakage, are 600 deg. or higher, but the majority of these boilers are so situated that larger units could not be readily used. Wherever space permits, the aim should be to reduce the outlet temperature as low as 400 deg., at which would be realized the maximum net saving per ton of steel, although not necessarily the maximum return on the investment. The size of boiler required for reducing the temperature from 1200 to 400 deg. is 2½ times the size for reducing to 600 deg., yet at not a proportionately greater investment. Water-cooling the gas and air valves results in a considerable loss when the recovery of waste heat is attempted. The heat lost may be recovered either by utilizing the cooling water for feeding the boiler or by substitution of brick-lined gas valves, thereby giving the waste gases a higher temperature on entering the boiler. Whereas now the average temperature is not over 1150 deg. for openhearth furnaces, there is no doubt that it can be increased to at least 1400.

The recovery of heat in the waste gases from regenerative soaking pits and heating furnaces presents additional encouraging possibilities, but as a primary consideration means must be adopted for greatly reducing the heat losses and excessive air leakage that appear to be characteristic of these types of furnaces. Even if the gas temperature be considerably lower than in openhearth practice, boilers will be found a paying investment, and heat recovery by this means does not cease to be economical until the temperature at the boiler inlet is as low as 700 deg.

Operating Experiences with Bleeder-Type Turbines*

Some eight years ago we used a 1500-kw. Parsons turbine arranged to operate condensing, bleeding or noncondensing. The economy of this turbine when running condensing on full load under our conditions was about 18 lb. per kw.-hr At a point where the secondary valve admits steam to the turbine, a connection was made to the heating system, and when the amount of steam required exceeded the limit of the bleeder connection, the turbine exhaust would be given to the heating system. With all the exhaust rejected to the heating mains at 13-lb. gage pressure, the turbine would deliver but 500 kw. at an exceedingly high steam consumption.

The bleeder connection was then tried, but as the steam expanded below the pressure the reducing valves in the exhaust were set for, there was no discharge until the secondary valve opened, when the steam of course discharged directly to the heating mains without entering the turbine. This was used for only a day or two, and since that time the turbine has operated successfully condensing. The result indicates that the originator of the idea was ahead of the designer of that date.

A 1100-kw. cross-compound condensing engine with auxiliary high-pressure cylinder was next tried. This was arranged to be connected so that both high-pressure cylinders

*From a paper before the National District Heating Association at Chicago, June 2, 1915.

discharged into a receiver from which steam could be bled to the heating system. If sufficient steam could not be secured from the receiver, the valves were taken from, and both high-pressure cylinders exhausted through, the low-pressure side to the heating system. Finally, all valves were replaced and the engine operated as a noncondensing compound unit, exhausting against a maximum pressure of 25 lb. with a receiver pressure of 50 lb. This proved the most satisfactory operating condition so far as lubrication, economy and maintenance were concerned.

These experiences showed us that the successful bleeder turbine should maintain a constant pressure on the heating system with varying electric loads, should be easily adjusted for the different heating pressures required to suit weather conditions, should deliver the maximum amount of steam with full expansion to the heating pressure required, and should show high economy operating as a straight condensing turbine during the nonheating season. It is believed that all the principal manufacturers now have turbines of this character.

There are several points to be watched in the operation of the bleeder turbines. All valves, strainers and piping should have ample size for the large volume of steam required when serving the heating system. The governors might be furnished with a greater range to enable the speed to be kept up when the turbine is bleeding the maximum amount of steam on heavy loads. At present the slight time element entering into the operation of the different mechanisms prevents perfect regulation. The non-return, or back-pressure valve, that prevents feeding back from the heating system in case the electrical load is lost should be tried out and tested frequently to prevent dangerous overspeed. When operating straight condensing on light loads, all stuffing-boxes, valves and piping forming part of the bleeder connection must be kept absolutely tight.

Should any sudden peak load or accident in the boiler room call for more steam than the entire boiler plant in use can supply, all the available steam can be almost instantly used through the turbine condensing, cutting off all steam from the heating system for a few minutes until normal operation is restored. This operating advantage of the bleeder turbine over any other combination unit has relieved some very serious situations in our case. The absence of all oils in the steam rejected for heating results in less odor, and also has made a great saving in the maintenance of traps, meters and air valves.

The claim is sometimes made that a pulsating supply of steam for heating purposes produces a better circulation, but our experience is that no difference in this regard can be detected. Proper connections to a bleeder-type turbine will take care of any deficiency in steam for heating the feed water, or an excess of steam from auxiliaries. Many standard condensing turbines are now being equipped for bleeding in, so that the power may be recovered from waste exhaust steam. Recently, with the exhaust from a 50-hp. condenser drive, a turbine manufacturer guaranteed that 80 hp. would be developed in the main unit when the steam, approximately 2000 lb. per hour, was inserted through holes already in the unit. A 1500-kw. turbine capable of bleeding 24,000 lb. of steam per hour at 5-lb. gage, when operated at rated loads and bleeding saves approximately 9500 lb. of steam per hour, as compared with operating the unit straight condensing and taking steam direct from the boilers. A proportionate gain, however, should not be expected in overall operation. Records taken over a period of four years show that the water taken per kilowatt hour is much lower during the heating season than is required for summer operation. The loss in capacity under maximum conditions is illustrated by a 3500-kw. turbine which bleeds sufficient steam at 16 lb. back pressure to supply 400,000 ft. of radiation, and 40,000 ft. of radiation in the mains. At the same time it will develop a maximum electrical load of 3000 kw., or while running condensing, 4500 kw.

If the control is virtually steam-tight, an undesirable heating of the blading below the control may result from friction if no steam passes to the condenser or atmosphere through the lower end. This is true also when bleeding in, if no steam passes through the high-pressure end. While these conditions should never prevail, they should be borne in mind.

Pennsylvania N. A. S. E. Convention

The sixteenth annual convention of the Pennsylvania State N. A. S. E. was held June 18 and 19 at Pittsburgh. The convention sessions and exhibit hall were both at the Monongahela House. The convention was opened on the morning of June 18 with an address by Past-National President Charles H. Garlick. Mayor Joseph G. Armstrong next welcomed the delegates to the city, and State President J. O. Rostron responded to his greeting. Col. Daniel Ashworth spoke on the industrial importance of Pittsburgh. The work of the "National Engineer" was described by National Secretary Fred. Raven, of Chicago. National Treasurer S. B. Force told the delegates of the many benefits derived from the state organization.

PITTSBURGH CONVENTION OF PENN STATE N. A. S. E.

The next event was the formal opening of the convention by State President Rostron and the naming of committees, after which the meeting adjourned to the exhibit hall for the official opening of exhibits by Harry Pastre, president of the National Exhibitors' Association. In the afternoon the Brunots Island plant of the Duquesne Light Co. was visited and in the evening the delegates were entertained by professional vaudeville talent. The morning session on June 19 was devoted to executive business and to the election of officers. In the afternoon the Duquesne Brewery was inspected. The list of exhibitors follows:

Anchor Packing Co.
Armstrong Cork & Insulation Co.
Armstrong, Wolfe, Zimmerman Co.
Arrow Boiler Compound Co.
Atlantic Refining Co.
Bowers Rubber Works.
Bowser & Co., S. F.
Crandall Packing Co.
Crane Packing Co.
Cutler-Hammer Manufacturing Co.
Dearborn Chemical Co.
Eagle Lubricating Co.
Elliott Co.
Fairbanks Co.
Foster Co., F. A.
Franklin Oil & Gas Co.
Garlock Packing Co.
Griscom-Russell Co.
Gynn Gas Burner & Engine Co.
Hawkeye Compound Co.
Homestead Valve Manufacturing Co.
Hommel & Co., Ludwig.
Jenkins Bros.
Johns-Manville Co., H. W.
Johnston, James H.
Johnston, Morehouse, Dickey Co.
Keystone Grinder & Manufacturing Co.
Knock & Ussher.
Lakin Manufacturing Co.
Lunkenheimer Co.
Monroe & Sons, R.
"National Engineer."
National Tube Co.
Ohio Injector Co.
Peerless Rubber Manufacturing Co.
Powell Co., William
"Power."
Pratt & Cady Co., Inc.
Quaker City Rubber Co.
Robertson Co., John F.
Rosedale Foundry & Machine Co.
Strong, Carlisle, Hammond Co.
Trill Indicator Co.
Vilter Manufacturing Co.
Wickes Boiler Co.

A. O. S. E. Convention

The American Order of Steam Engineers held its twenty-ninth annual convention at Atlantic City, N. J., June 21-23, with headquarters at the Continental Hotel. The business meetings were held in the Morris Guards' Armory, the American Supplymen's Association holding its mechanical exhibition in the drillroom of this building. The opening exercises took place on the morning of June 21, when the delegates and guests were welcomed to the city by Mayor Riddle. Supreme Chief William Pairent responded for the engineers. The exhibit hall was formally opened on the same evening with appropriate addresses by Mayor Riddle, Supreme Chief Pairent and others.

On the evening of June 22 a smoker was held in the main dining hall of the Hotel Islesworth, when an enjoyable program of vocal and instrumental numbers, recitations and stories was given by Billy Murray, of Jenkins Bros.; Jack Armour, of "Power," and a host of complimentary vaudeville talent from the Steel Pier. The local committee on arrangements included A. H. Franck, J. A. Best, W. A. Hardin, E. M. Plummer and W. S. Price.

On the afternoon of June 23 special trolley cars conveyed the convention to the Inlet, where steamboats were boarded for a pleasant sail about Egg Harbor Bay. At the final meeting on the same day, Col. Lewis Bryant, commissioner of labor for the State of New Jersey, addressed the delegates.

On the evening of June 23 there was an impressive memorial service for those engineers and supplymen who had passed away during the year. A white rose was dropped on the pulpit to the memory of each departed brother.

The newly elected supreme officers of the American Order of Steam Engineers are: J. William Pairent, chief engineer; John McKewen, first assistant chief; John Martin, recording engineer; Edward A. Reboul, corresponding engineer; Solomon Fehnel, senior master mechanic; John H. Mondy, junior master mechanic; Henry Meeser, inside sentinel; John J. Morris, outside sentinel; Hiram W. Trout, chaplain; James K. Holland, trustee, and William H. Tyson, treasurer. The officers were installed by Past-Supreme Chief George W. Richardson. New York City was selected for the June, 1916, meeting.

DELEGATES TO ATLANTIC CITY CONVENTION JUNE 21, AMERICAN ORDER OF STEAM ENGINEERS

The American Supplymen's Association at its final meeting elected the following officers for the ensuing year: Charles A. Wilhoft, president; Hart Hill, vice-president; Porter G. Jones, secretary; John W. Armour, treasurer; A. E. Smith, director of exhibits. The Executive Committee includes Harry E. Louder, William Morgan, George Dickel, George Starrs, Samuel McCullam, Walter Edge, Andrew Lauterbach, Joseph Gordon and A. D. Wyckoff.

AMERICAN SUPPLYMEN'S ASSOCIATION AT ATLANTIC CITY, JUNE 21

Before adjournment, Past-President Harry E. Louder was presented with a handsome token by his fellow-supplymen. The list of exhibitors follows:

Albany Lubricating Co.
Allen & Co., A. T.
Anchor Packing Co.
B. J. Packing Co.
Bowser & Co., S. F.
Borgner Co., Cyrus
Budd Grate & Foundry Co.
Dearborn Chemical Co.
Dick, Ltd., R. & J.
Dixon Crucible Co., Joseph
Engineering Supply Co.
France Packing Co.
Frick Packing Co.
McArdle & Cooney
McLeod & Henry Co.
N. Y. Belting & Packing Co.
Peerless Rubber Co.
Philadelphia Bourse
Philadelphia Grease Manufacturing Co.
"Popular Engineer"
"Power"
"Practical Engineer"
Quaker City Rubber Co.
Richard & Co., S. R.
Robinson Son Co., William

Garlock Packing Co.
Gray Engineering Combustion Co.
Greene, Tweed & Co.
Griscom-Russell Co.
Home Rubber Co.
Houghton & Co., E. F.
Huyette Co., Paul B.
Jenkins Bros.
Keystone Lubricating Co.
Lagonda Manufacturing Co.
Livezey, John R.
Lunkenheimer Co.
McAllister Coal Co.
Rooksby & Son Co., E. J.
Roto Co.
Specialty Sales Co.
Squires Co., C. E.
Texas Co., The
Underwood Co., H. B.
Warley & Co., Thomas C.
Webster Co., Warren
Watson & McDaniel & Co.
Westinghouse Lamp Co.
York Belting & Packing Co., G. F.
Zurn Co., O. F.

Convention of Connecticut State Association

The twentieth annual convention of the Connecticut State Association of the N. A. S. E. was held June 25 and 26 in Hartford. The Bond Hotel Annex was the headquarters. Fort Guard Hall, in close proximity to the headquarters, was arranged for the meetings of the delegates and also for the mechanical display. There was an unusually large number of exhibitors, the 76 booths occupied being the largest number in the history of the state organization.

The exhibit hall was formally opened June 25. In the evening at 8 o'clock the preliminary exercises of the convention occurred. Mayor Joseph H. Lawler welcomed the convention to Hartford and hoped that its stay would be pleasant and profitable. Past-National President Joseph F. Carney and National Vice-President Walter Damon replied for the engineers. William J. Reynolds, past-national president, talked of the benefits of the N. A. S. E. and of the "National Engineer." John Foote, of the McLeod & Henry Co., also spoke. An enjoyable entertainment was furnished by Billy Murray, of Jenkins Bros.; Herbert Self, of the Peerless Rubber Manufacturing Co., and Ralph Mixer's orchestra.

At the final meeting of the delegates the following state officers were elected: James H. McGee, president; Elmer E. Thomas, vice-president; H. C. Brown, secretary and treasurer; O. A. Thomas, conductor; A. Anderson, doorkeeper; W. H. Goodrich, B. J. Reynolds, C. D. Osborne, trustees; F. H. Hastings, state deputy.

The Connecticut State Supplymen's Association elected its officers for the ensuing year, as follows: John H. Foote, honorary president; Thomas H. Platt, president; John Lotz, vice-president; Harry Glynne, secretary and treasurer; other members of the executive committee, Frank C. Bulkley, John B. Harrington, Norman S. Burnham, William Muller, Fred P. Upson.

The final event of the convention was the banquet served at the Bond Hotel on the evening of June 26. Frank Bulkley, as toastmaster, introduced several engineers and supplymen who gave short addresses. Herbert Self entertained with songs and Jack Armour told stories and gave recitals.

The list of exhibitors follows:

Adkins & Son, E. S.
Albany Lubricating Co.
American Steam Gage & Valve Co.
Ames Iron Works Co.
Ashcroft Manufacturing Co.
Baldwin Stewart Electric Co.
Billings & Spencer Co.
Bond Hotel
Chapman Valve Manufacturing Co.
Commercial Chemical Co.
Dearborn Chemical Co.
Keashey Co., Robert A.
Keystone Lubricating Co.
LeGate, Charles A.
Lunkenheimer Co.
McClave-Brooks Co.
McCormick, W. L.
McLeod & Henry Co.
Mersick & Co., C. S.
"National Engineer"
Nightingale & Childs Co.
Open Coal Heater & Purifier Co.
Peerless Rubber Manufacturing Co.
Perfection Grate Co.
Philadelphia Grease Mfg. Co.
Plimpton & Hills Corp.
"Power"
Pratt & Cady Co.
Quaker City Rubber Co.
Restein Co., Clement
Roto Co.
Sisson Drug Co.
Skinner Engine Co.
Spencer Turbine Cleaner Co.
Strong Machine & Supply Co.
Terry Steam Turbine Co.
Travelers Insurance Co.
Vanderman Bros.
Voorhees Rubber Manufacturing Co.
Whitlock Coil Pipe Co.
Winn, William R.

Diamond Power Specialty Co.
Eagle Oil & Supply Co.
Edward Valve & Manufacturing Co.
Fairbanks Co., The
Franklin Electric Manufacturing Co.
Ford Co., J. B.
Garlock Packing Co.
Hart-Hegeman Manufacturing Co.
Hartford Engine Works
Hartford Mill Supply Co.
Haskell, George
Home Rubber Co.
Howes, C. L., M. E.
Jenkins Bros.
Johns-Manville Co., H. W.
Johns-Pratt Co.

Fatigue of Steam Pipes

In a paper recently presented before the institution of the Naval Architects, C. E. Stromyer presented facts in regard to the failure of steam pipes due to vibration, as developed from the Board of Trade inquiries. The report summarizes the causes of failure in a large number of instances where copper pipe failed under repeated strains from vibration and a significant statement is made that "among the reports on steam-pipe failures there are none which may be attributed to fatigue of mild steel. Copper pipe in one case failed in a few days, whereas if steel pipe were used it is reasonably certain it would last forever."

As most of the pipes dealt with were copper, if operated under similar conditions it is obvious that the number of explosions would have been greatly reduced had steel pipes been used instead of copper.

HARTFORD CONVENTION OF CONNECTICUT N. A. S. E.

Spring Meeting of A. S. M. E.

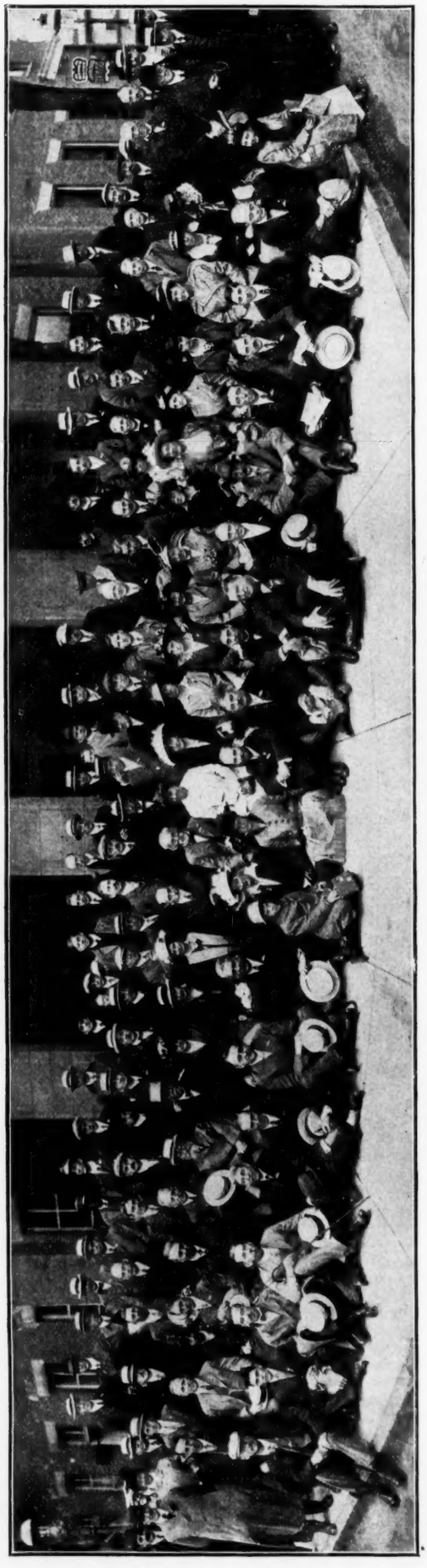
Notwithstanding the diversion afforded by the simultaneous meeting of the American Society for Testing Materials at Atlantic City and the fact that many members who usually attend the spring meeting will attend the meeting and congresses at San Francisco instead, the meeting of the American Society of Mechanical Engineers, at Buffalo, during the week commencing June 21, brought out a registration of 425. Under other conditions the program offered could not have failed to attract a larger attendance, and the efforts put forth by the local committee in providing entertainment and excursions well repaid those who were present.

Headquarters opened for registration on Tuesday afternoon, and on Tuesday evening there was an address of welcome by Frank D. Baird, representing the industries of Buffalo. The president of the society, Dr. John A. Brashear, responded in his usual full-hearted and jovial manner.

Wednesday was spent at Niagara Falls, where the party was conveyed by special electric cars and where a business and professional session was held in the forenoon.

Following luncheon at the International Hotel, trips were made to the hydro-electric plants on the Canadian and American sides, the Carborundum and other works, to the Gorge and such points of interest as were individually attractive.

In the evening an illustrated lecture was given by Dr. F. H. Newell, formerly chief of the United States Reclamation Service, on the reclamation work in the West, showing a number of hydraulic projects, including the Roosevelt dam and other notable pieces of engineering work. All of the views were from beautifully colored lantern slides.



SOME OF THE ATTENDANTS AT THE SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Thursday morning there were two simultaneous sessions in the Hotel Statler; Thursday afternoon more visits to plants and points of interest, with a tea served by local ladies at the Twentieth Century Club; and in the evening the usual reception and dance, constituting the principal social function of the meeting. The music and collation were especially fine, and the event was a success in every particular.

The last session was held on Friday morning, and the afternoon was left for those who cared to do so to take advantage of the many invitations to visit manufacturing plants and places of engineering interest.

An amendment to the constitution was adopted, adding to the list of standing committees a Committee on Standardization.

Notice was given of intention to submit amendments at the annual meeting providing that any group forming 1 per cent. or more of the persons entitled to vote may constitute itself a special nominating committee with the same powers as the nominating committee appointed by the president; and that the society shall claim the exclusive copyright to any reports of its duly appointed committees. The council shall waive such copyright for specific reports.

The Committee on Standardization reported on special threads for fixtures and fittings, dealing particularly with rolled threads such as are used upon electric-light bulbs. For the first time, the Nominating Committee reported at a spring meeting, under the requirements of the amendment to the by-laws adopted last February, its recommendations for the officers to be elected at the fall meeting. Their recommendation for president is D. S. Jacobus, advisory engineer to the Babcock & Wilcox Co. and special lecturer in experimental engineering at Stevens Institute of Technology. Professor Jacobus joined the society in 1889, was a manager from 1900 to 1913 and vice-president from 1903 to 1905. He has served with distinction upon many committees, and has just rendered yeoman service in connection with the advisory committee of the Boiler Code. He is not only exceedingly popular, but would bring to the office a live interest in the society's affairs and exceptional capacity for dealing with the problems of its administration.

For vice-president the committee suggests the names of William B. Jackson (of Dugald C. and William B. Jackson, consulting engineers, largely to the electrical and public-service corporations), who joined the society in 1901 and was a manager from 1912 to 1915; J. Sellers Bancroft, general manager and mechanical engineer of the Lanston Monotype Machine Co., who joined the society in 1880, and was a manager from 1909 to 1911, and Julian Kennedy, consulting engineer, Pittsburgh, Penn., largely to the steel interests, who joined the society in 1912 and has not hitherto held office.

For managers the Nominating Committee suggests the names of John H. Barr, consulting engineer for the Remington Typewriter Co., who joined the society in 1889; John A. Stevens, consulting engineer, Lowell, Mass., largely to the textile industries, who joined the society in 1902, and who is chairman of the Committee on Boiler Code, and H. de B. Parsons, professor emeritus of Rensselaer Polytechnical Institute and consulting engineer, largely for power-plant work, who joined the association as a junior in 1885 and was raised to full membership in 1887. None of the nominees for manager has held office in the society previously.

The Boiler Code Committe reported to the Council that it was the opinion of the committee that the official symbol or stamp should be affixed by the manufacturer of a boiler, to indicate that the American Society of Mechanical Engineers' rules have been complied with in its construction. Certification may be governed by law or contract.

The committee further requested that it be empowered to make rulings where inquiries are made respecting constructions not covered by the Code, and to interpret any parts of the Code, and that it be empowered to take up the subjects of economizers, pressure vessels other than steam boilers, rules for operation and care of steam boilers and pressure vessels and special recommendations.

Among the papers presented the following, of special interest to "Power" readers, will receive attention in other columns and issues: "The Use of Corrugated Furnaces for Vertical Fire Tube Boilers," by F. W. Dean; "On Measuring Gas Weights," by Thomas E. Butterfield; "A Basis for Rational Design of Heat Transfer Apparatus," by E. E. Wilson; "Influence of Disk Friction on Turbine Pump Design," by F. zur Nedden; "The Surface Condenser," by C. F. Braun; "The Effect of Relative Humidity on an Oak Tanned Leather Belt," by W. W. Bird and F. W. Roys; "On the Laws of Lubrication of Journal Bearings," by M. D. Hersey, of the Bureau of Standards.

The accompanying photograph of such of the attendants as could be rounded up after the luncheon was taken in front of the International Hotel at Niagara Falls.

Ohio Engineers Meet at Toledo

The thirty-first meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers was opened by President W. C. McCracken on the evening of June 17 at the Hotel Secor, Toledo. The feature of the first session was the paper entitled "The Use of Current-Limiting Reactors," by W. M. Dann and H. H. Rudd, both of the Westinghouse Electric & Manufacturing Co. The paper considered briefly the construction, cost and rating of the latest type of reactors. Primarily for the protection of generators, reactance coils are also valuable in protecting and regulating feeder circuits. The advantages gained in the latter installations were given.

The program for June 18 was a day's outing, but technical sessions were held on the boat trips to and from Put-In-Bay. George H. Gibson, of the Harrison Safety Boiler Works, stated in his paper, "Establishing and Maintaining Boiler-Room Economy," that boiler-room economy depended less upon equipment than upon operation. To secure efficient operation, accurate quantitative knowledge of fuel consumption and steam production is absolutely essential. To improve conditions such data as output, evaporation per pound of coal and cost of steam must be known. The boiler should be arranged for the convenient taking of gas samples and for determining temperatures. Other essential adjuncts are a feed-water meter and scales for weighing the coal and ashes. The paper was concluded with a detailed description of the Sorge-Cochrane metering heaters. W. P. Alliger, also of the Harrison Safety Boiler Works, next emphasized the importance of keeping boilers free from scale, and told how this might be done by softening the water. Analyses of various feed waters before and after treatment were presented, and the effect on boiler operation noted. This led to an outline of the advantages of the Sorge-Cochrane hot-process water-softening system.

W. A. Heisel, of the Charles Taylor Sons Co., delivered an interesting paper on "Firebrick for Boiler Settings," which was published in our June 29 issue. The disadvantages of using a firebrick mortar made from the same clay as the firebrick itself, which at one time was considered good practice, were dealt upon by J. O. Boylan, of the H. W. Johns-Manville Co. He also described a high-grade refractory cement especially adapted for boiler-setting work.

J. M. Faris spoke on "The Safety Problem, Its Possibilities and Limitations." From his experience at the plant of the Youngstown Steel & Tube Co., he concluded that while one-third of the accidents are due to lack of proper mechanical safeguards, two-thirds are dependent on the human element, and these can be diminished by the education of the worker and by his proper physical examination. L. A. Cole gave a paper, "Stops and Nonreturn Valves on Boiler and Engine Steam Pipes." In referring to the rules formulated by the Industrial Commission of Ohio, Mr. Cole stated that they required the use of stop valves as a protection to boilers only, but should refer as well to steam lines. Instead of using two stop valves in the boiler lead to the header, he recommended the use of one stop valve and one double-seated type of stop and check valve. In addition, automatic valves, or at least a quick-closing gage valve with a chain attached and hung so as to be easily reached by the engineer, should be placed on all engine branches.

The final session of the convention was held on the evening of June 18, when E. H. McFarland, of the General Electric Co., gave a paper, "Low- and Medium-Pressure Turbines," showing that in 20 years the turbine has been brought to the same state of efficiency as was the steam engine in 100 years. Present machines sell for 60 per cent. less than the original pattern, and the efficiency is from 25 to 30 per cent. greater. An interesting part of the paper dealt with a tentative battleship propulsion consisting of two 13,000-kw. turbo-generators and four 9000-hp. motors. For this equipment the economy guarantee did not vary one pound per shaft horsepower-hour in a speed variation from 12 to 22 knots. It was estimated that a shaft horsepower-hour would be developed on 9 lb. of steam. A short résumé of the possibility and efficiency of the mercury boiler completed the paper, and concluded, as voted by all attending, a profitable convention.

Meeting of American Society for Testing Materials

The eighteenth annual meeting of the American Society for Testing materials was held at the Hotel Traymore, Atlantic City, N. J., June 22-26. Over 400 members and guests participated in the comprehensive program that had been announced, and their presence was additionally rewarded by superb weather conditions for enjoying the attractions of the Convention City by the Sea.

The following is a summary of the program: Tuesday, a.m., General; p.m., Nonferrous Metal. Wednesday, a.m., Steel; p.m., Heat Treatment of Steel. Thursday, a.m., Testing Apparatus; p.m., Cement and Concrete. Friday, a.m., Ceramics, Gypsum and Lime; p.m., Preservative Coatings and Lubricants. Saturday, a.m., Road Material, Timber and Rubber.

The following officers were elected: President, Mansfield Merriman, New York; vice-president, William H. Bixby, Washington, D. C. Executive Committee: James H. Gibboney, Roanoke, Va.; William K. Hatt, Lafayette, Ind.; John A. Matthews, Syracuse, N. Y.; Edward Orton, Jr., Columbus, Ohio.

THE OHIO SOCIETY DELEGATION AT TOLEDO BEACH

STANDARD SPECIFICATIONS FOR COAL

Among reports of the various committees was that of Committee D-5 on standard specifications for coal.

As reported at the sixteenth annual meeting of this society, in 1913, Committee D-5, following its appointment in 1909, was divided into several subcommittees, each charged with considering the subject of specifications for the purchase of coal for particular purposes, as steaming and power-plant use, household and domestic use and gas making. The members of the several subcommittees, except that on the specifications for coal for steaming and power-plant purposes, agreed as a result of their endeavors that existing knowledge was inadequate as a basis for satisfactory specifications.

Much more work has been done on the specifications for coal to be used for steaming and power-plant purposes, and important progress has been made, based on actual experience as well as on laboratory work, toward the framing of satisfactory specifications for such coal. A few details, however, especially those relative to the methods of sampling the coals to be purchased under the specifications, had not been worked out to the satisfaction of a majority of the members of the committee.

After the committee had reported to the society in 1913, the various subcommittees were united into a general committee. This committee has given serious consideration to the preparation of standard specifications for the purchase of coal used for steaming and power-plant purposes, much work having been done by the individual members, as well as by the committee at its meetings.

After a full discussion of the subject at a meeting on Apr. 18, 1914, the consensus of opinion was that, as the purchase of

coal under specifications is in a state of evolution and development, and as experience and time are required to develop standards, the time had not yet arrived for the preparation of standard specifications.

At a meeting held Jan. 9, 1915, the committee decided to confine its discussions and action for the time being to the development of a method of sampling coal. Accordingly, and as a result of the work of the committee to date, a proposed method for the sampling of coal was submitted, with the recommendation that it be printed in the "Year-Book" for one year as tentative.

The committee considers that through the preparation of a tentative method of sampling coal, real and substantial progress will be made toward the preparation of standard specifications for the purchase of coal. The success of any method of purchase under specifications depends on sampling. If the sampling is improperly done, the analyses are unreliable, controversies ensue, the specification method is discredited, and the development of standard specifications is retarded. By the preparation of a method of sampling, the committee believes it has paved the way for continuing its efforts, which may ultimately result in the preparation of standard specifications.

PROPOSED TENTATIVE METHOD FOR THE SAMPLING OF COAL*

It is imperative that every sample be collected and prepared carefully and conscientiously and in strict accordance with the standard methods described herein, for if the sampling is improperly done, the sample will be in error, and it may be impossible or impracticable to take another sample; but if an analysis is in error another can easily be made of the original sample.

Gross samples of the quantities designated herein must be taken whether the coal to be sampled consists of a few tons or several hundred, because of the cardinal principle in sampling coal that must be recognized and understood, and is subsequently stated. The effect of the chance inclusion or exclusion of too many or too few pieces of slate or other impurities in what, or from what, would otherwise have been a representative sample will cause the analysis to be in error accordingly, regardless of the tonnage sampled. For example, the chance inclusion or exclusion of 10 lb. too much or too little of impurities in or from an otherwise representative sample of 100 lb. would cause the analysis to show an error in ash content and in heat units of approximately 10 per cent., whereas for a 1000-lb. sample the error would be approximately only 1 per cent.; the effect being the same whether the sample is collected from a 1-ton lot or from a lot consisting of several hundred tons.

When this method of sampling is to be employed as a part of any contract or agreement, the following provisions must be specifically agreed to by the parties to such contract or agreement: (a) The place at which the coal is to be sampled (see Sec. 1); (b) the approximate size of the sample required when the standard conditions do not apply (see Sec. 3); (c) the number of samples to be taken or the amount of coal to be represented by each sample when the standard conditions do not apply (see Sec. 4).

1. The coal shall be sampled when it is being loaded into, or unloaded from, railroad cars, ships, barges or wagons, or when discharged from supply bins, or from industrial railway cars, or grab buckets, or from any coal-conveying equipment, as the case may be.

2. To collect samples, a shovel or specially designed tool or mechanical means shall be used for taking equal portions or increments of sufficient size to include the largest pieces of coal and impurities. For slack or small sizes of anthracite, increments as small as 5 to 10 lb. may be taken, but for run-of-mine or lump coal, increments should be at least 10 to 30 lb.

3. The increments shall be regularly and systematically collected, so that the entire quantity of coal sampled will be represented proportionately in the gross sample, and with such frequency that a gross sample of the required amount shall be collected. The standard gross sample shall not be less than 1000 lb., except that for slack coal and small sizes of anthracite in which the impurities do not exist in abnormal quantities or in pieces larger than ¾ in., a gross sample of approximately 500 lb. shall be considered sufficient. If the coal contains an unusual amount of impurities, such as slate, and if the pieces of such impurities are very large, a gross sample of 1500 lb. or more shall be collected. The gross sample should contain the same proportion of lump coal, fine coal and impurities as is contained in the coal sampled. Provision should be made for the preservation of the integrity of the sample.

4. A gross sample shall be taken for each 500 tons or less, or in case of larger tonnages, for such quantities as may be agreed upon.

5. After the gross sample has been collected, it shall be systematically crushed, mixed and reduced in quantity to convenient size for transmittal to the laboratory. The sample may be crushed by hand or by any mechanical means, but under such conditions as shall prevent loss or the accidental admixture of foreign matter. The pieces of coal and impurities shall be crushed to sizes not greater in any dimension than the following:

Largest Size of Coal and Impurities Allowable in Sample Before Division, In.	Minimum Weight of Sample After Division, Lb.
1	500 or over
¾	250
½	125
⅜	60
¼	30
$\frac{3}{16}$ or 4-mesh screen	10

The sample delivered to the laboratory shall be not less than 10 lb. when crushed to $\frac{3}{16}$ in., or 4-mesh size. In case provision is to be made for duplicate laboratory samples, they shall be taken from the remainder of the 30 lb. when crushed to $\frac{3}{16}$ in. or 4-mesh size.

6. (a) When prepared by hand, the gross sample shall be reduced in quantity by stages; before each reduction it shall be crushed to the fineness already prescribed and shall be thoroughly mixed. The following method shall be used in reducing the gross sample to approximately 250 lb.

The crushed coal shall be shoveled into a conical pile and then formed into a long pile in the following manner: The sampler shall take a shovelful of coal from the conical pile and spread it out in a straight line 5 to 10 ft. long. His next shovelful shall be spread directly over the top of the first, but in the opposite direction, and so on back and forth, the pile being occasionally flattened, until all the coal has been formed into one long pile. The sampler shall then discard half of this pile, proceeding as follows:

Beginning on one side of the pile, at either end, and shoveling from the bottom of the pile, the sampler shall take one shovelful and set it aside; advance along the side of the pile a distance equal to the width of the shovel and at this place take a second shovelful and discard it; again advancing in the same direction one shovel width, he shall take a third shovelful and add it to the first, the fourth to be taken in a like manner and discarded, the fifth retained, and so on, the sampler advancing always in the same direction around the pile so that its size will be gradually reduced in a uniform manner. When the pile is removed, about half of the original quantity of coal should be contained in the new pile formed by the alternate shovelfuls which have been retained.

(b) After the gross sample has been reduced by the method cited to approximately 250 lb., further reduction in quantity shall be by the quartering method. Before each quartering, the sample shall be thoroughly mixed and made into a conical pile, in the following manner:

Quantities of 125 to 250 lb. shall be shoveled into a new conical pile by depositing each shovelful of coal on top of the preceding one; quantities less than 125 lb. shall be placed on a suitable cloth, measuring about 6x8 ft., mixed by raising first one end of the cloth and then the other, so as to roll the coal back and forth, and after being thoroughly mixed shall be formed into a conical pile by gathering together the four corners of the cloth. The quartering of the conical pile shall be done as follows:

The cone shall be flattened, its apex being pressed down with a shovel or board, so that after the pile has been quartered each quarter will contain the material originally in it. The flattened mass, which shall be of uniform thickness and diameter, shall then be marked into quarters by two lines that interesect at right angles directly under a point corresponding to the apex of the original cone. The diagonally opposite quarters shall then be shoveled away and discarded and the space that they occupied brushed clean. The coal remaining shall be successively crushed, mixed, coned and quartered until two opposite quarters shall equal approximately 30 lb. of $\frac{3}{16}$-in. or 4-mesh size, from which the 10-lb. sample shall be taken and shipped to the laboratory in a suitable container.

7. Only such mechanical means as will give equally representative samples shall be used in substitution for the hand method of preparation herein standardized.

8. If the accumulation of a sample extends over any considerable period of time, what would otherwise be a gross sample may be worked down in successive stages to samples of a size suitable for transmittal to the laboratory, and these fractional samples may be analyzed and the several analyses averaged; or the several samples may later be mixed at the

*Criticism of these tentative methods is solicited and should be directed, preferably before Jan. 1, 1916, to G. S. Pope, secretary of Committee D-5 on Standard Specifications for Coal, Bureau of Mines, Washington, D. C.

place of sampling or in the laboratory and reduced to one sample, one analysis being made. In the averaging of analyses or in the mixing of the several samples, weights shall be used proportionate to the tonnages which the fractional samples represent.

9. The special moisture sample shall weigh approximately 100 lb. and shall be accumulated by placing in a waterproof receptacle with a tight-fitting and waterproof lid small equal parts of freshly taken increments of the standard gross sample. The accumulated moisture sample shall be rapidly crushed and reduced mechanically or by hand to about a 5-lb. quantity, which shall be immediately placed in a container and sealed air-tight and forwarded to the laboratory without delay.

10. Only when equally representative results will be obtained is the standard gross sample to be used instead of the special moisture sample for the determination of total moisture.

FUSIBILITY OF COAL ASH

A paper on "The Fusibility of Coal Ash" was presented by A. C. Fieldner, A. E. Hall and A. L. Feild.

The growing demand for the inclusion in coal specifications of the "softening" or "fusing" temperature of the ash as a safeguard against excessive clinker troubles has led the Bureau of Mines to take up a study of laboratory methods of determining fusibility and the relation of the results to clinker formation under practical furnace conditions.

The paper gave a summary of the results obtained in a study of the various factors that influence the softening temperature of ash when molded in the form of Seger cones. There is described also a new method of making the Segercone test, whereby the ash is caused to soften and form slags similar to those found in fuel-bed clinkers.

The complete report of this investigation will be published in a technical paper of the Bureau of Mines.

Comparative tests were made on a series of 18 types of coal ash, in six different furnaces such as are in more or less common use, for determining the degree of fusibility of silicate mixtures. It was found that the softening temperature of a given ash was influenced by the following factors: (1) Shape and size of cone, (2) inclination of cone, (3) fineness of ash, (4) rate of heating, (5) oxidizing or reducing nature of atmosphere in which the cone was heated.

The nature of the atmosphere had by far the largest influence on the softening temperature, causing differences as high as 400 deg. C. in some cases. The highest results were obtained either in air with no reducing gases present or in a strong reducing atmosphere whereby the iron oxides were reduced to metallic iron. The lowest results were obtained in such atmospheres as were able to reduce the iron oxide to the ferrous form, but not to the metallic state.

A new method for determining this lowest softening temperature was then developed, whereby the iron was caused to combine in the slag principally in the ferrous state, by heating the ash in an atmosphere of approximately equal parts by volume of hydrogen and water vapor. A comparison of analyses of actual clinker slags from boiler furnaces and of the ash cones fused in the 50 : 50-per cent. hydrogen-water vapor mixture showed the iron component in both cases to be principally in the ferrous state. Therefore, the proposed fusibility test should have a closer relation to clinker formation than tests made in oxidizing atmospheres that produce slags in which the iron exists principally in the ferric state.

FAILURE OF MATERIAL UNDER REPEATED STRESS

A paper on "The Failure of Materials Under Repeated Stress" was presented by H. F. Moore and F. B. Seely.

The behavior of materials under repeated stress shows important variations from the action under static stress. Nearly all the ideas of repeated stress have been developed from considerations of static loading. One very common idea is that for any given material there is a definite elastic limit below which the behavior of the material is perfectly elastic. Under static loads such a conception may be regarded as exact without involving serious error, though careful writers on the mechanics of materials have for a long time recognized that no absolute elastic limit has ever been fixed for any material.* In structures under static load local stresses of considerable magnitude—frequently beyond the yield point of the material —exist without producing any appreciable effect on the stability or the deformation of the structure as a whole, and such stresses are frequently neglected in structures subjected to static load. If, however, the load on a structural part or a machine member is repeated many times such local overstress may cause a crack to start, which, spreading, eventually destroys the member; or inelastic action too small to be detected even by delicate static tests of material may by cumulative action cause serious damage under oft-repeated loading.

An illustration of the difference between static and repeated loading is furnished by the action of wire ropes bent around sheave wheels. The fiber stress due to bending is high and frequently causes inelastic action, which, however, is confined to a small portion of each wire. This inelastic action is very difficult to detect by means of static tests, but as the wire is repeatedly bent around sheave wheels this high local stress starts cracks that eventually cause rupture of individual wires. In this case, as in many others, the conception of perfect elastic action, allowable for static loading, must be discarded for repeated loads.

For a range of fiber stress extending from the yield point of the material (for brittle materials the ultimate strength) down to a stress slightly lower than the elastic limit, as determined by laboratory tests of the usual precision, repeated stress will cause failure, and there seems to exist a fairly definite relation between fiber stress and the number of repetitions necessary to cause failure. This relation was pointed out by Basquin† before this society. It may be expressed by the formula, $S = KN^q$, in which S = intensity of fiber stress in pounds per square inch, N = the number of repetitions of stress to cause failure, and K and q are experimentally determined constants. A similar relation was noted later by Eden, Rose and Cunningham‡ and by Upton and Lewis.§ Whether for still lower stresses such a law holds, or whether there is an "endurance limit" below which failure will not occur under any number of repetitions of stress, however many, is a question which was also discussed by the authors.

The authors of the paper propose an explanation of the formula based on the structural damage done to material by inelastic action during application and removal of load. For still lower stresses no positive evidence of a fixed endurance limit has been found for commercial materials, and various methods used for locating such a supposed limit give varying results from the same test data. A modification of the exponential formula is proposed for low stresses and tentative values are given for the proposed formulas, together with a general discussion on action under repeated stress.

REPORT OF COMMITTEE D-2 ON STANDARD TESTS FOR LUBRICANTS

For the determination of viscosity, the committee reaffirms its recommendation of last year to the society that the Saybolt Standard Universal Viscosimeter be the standard. The very careful investigation of Dr. C. W. Waidner, of the Bureau of Standards, showing that the Saybolt instrument posseses as great accuracy as any other viscosimeter used for the determination of the viscosity of lubricants, confirms the previous opinion of the committee. The Saybolt viscosimeter is the instrument in practically universal use in the United States for the determination of the viscosity of lubricants and possesses many other advantages covered by the committee's report of last year.

On the question of an alternate instrument for viscosity, the committee after very careful consideration has concluded that the adoption of an alternate instrument would entirely destroy the value of a standard instrument. The committee realizes, however, that there are many who for years past have used other instruments than the Saybolt and will probably continue to do so, and in order not to work undue hardship in these cases, the committee is now submitting, and will submit from time to time, conversion tables for converting readings on various viscosimeters into readings on the Saybolt Standard Universal Viscosimeter. Appended to the report is the result of the investigation of Dr. Waidner on conversion of readings on the Engler and Redwood viscosimeters into readings on the Saybolt Standard Universal Viscosimeter, and means to be taken for the standardization of the three viscosimeters is also covered. Since it is occasionally required that the viscosity of lubricants be expressed in terms of absolute viscosity, and since tables have already been prepared by Dr. L. Ubbelohde for converting readings on the Engler instrument into absolute viscosity, conversion tables have also been added covering the conversion of readings on the Saybolt and Redwood instruments into terms of Engler.

*Thurston, "Text-Book of Materials of Construction," p. 348; Burr, "The Elasticity and Resistance of Materials of Engineering," p. 200; Wawrziniok, "Handbuch des Materialsprüfungwesen," p. 9; Unwin, "The Testing of Materials of Construction," p. 13.

†"The Exponential Law of Endurance Tests," "Proceedings," Am. Soc. for Testing Materials," Vol. X, p. 625 (1910).

‡"The Endurance of Metals," "Proceedings," Inst. Mech. Engrs. (British), Parts 3 and 4, p. 389 (1911).

§"The Fatigue Failure of Metals," "American Machinist," Oct. 17 and 24, 1912.

The committee recommends that the proposed standard tests for lubricants which accompanied the report, covering viscosity, specific gravity, free acid and cloud and pour tests, be referred to letter ballot of the society.

The committee has also under consideration standard methods of test for saponification value, carbon residue, evaporation, emulsification, sulphur determination and differentiation, precipitation, flash and fire point and gumming.

PENNSYLVANIA R.R. LABORATORY

The new physical and chemical laboratory of the Pennsylvania R.R. Co. at Altoona Penn., was described by C. D. Young, engineer of tests, Pennsylvania R.R. Co., in a paper treating of the activities of the company's department of inspection and tests and its value in safeguarding the lives and property of its patrons.

The new laboratory building in Altoona was illustrated and described, together with a list of the more important features of its equipment and organization. Following a list of the materials bought under specifications, the paper briefly treats of the more important general divisions of the test department and chemical laboratory work.

Referring to the value of such a department, the author of the paper stated that neither the reputation of the manufacturer nor a superficial inspection of the materials offered has been found to be a sufficient safeguard in the purchase of supplies, since frequently the manufacturer himself has no positive knowledge of the strength or other physical properties of the iron, steel or other materials, or of the purity of many of the articles offered for sale.

The building itself cost about $150,000. The value of the contents is estimated at $100,000 for the physical laboratory and $25,000 for the chemical laboratory, making the investment with complete equipment about $275,000.

A paper presented by Prof. Alan E. Flowers, of the Ohio State University, on "A Cylinder Friction and Lubrication Testing Apparatus," will be published in a future issue.

OBITUARY

William H. Cronley died June 24, at the age of 72, after a short illness. For the past 15 years or more he was chief engineer at the City Hall, Jersey City, N. J., and a member of that city's Board of Examiners. He was one of the earliest members of, and most active workers in, the National Association of Stationary Engineers and a prominent figure at its conventions. He served efficiently as national treasurer for a number of years. The establishment of the Jersey City Association, No. 1, was due to his efforts, and its meetings were presided over by him for many years. He was a veteran of the Civil and Indian wars and an active member of Henry Wilson Post, G. A. R. A widow, five daughters and one son survive him.

WILLIAM H. CRONLEY

Elmer Crawford died June 15, in Chicago, at the age of 53. After graduating from the academic and law departments of the University of Michigan, he engaged in newspaper work in Detroit for a number of years. In 1899 he became connected with "The Tradesman," in the following year with "Domestic Engineering," and in 1910 he established the Crawford Publishing Co. At the time of his death he was its president and was also editor of "Mill Supplies," the company's principal publication.

PERSONALS

Stewart M. Marshall, formerly chief engineer, Cambria Steel Co., Johnstown, Penn., is managing the turbine department of the Southwark Foundry & Machine Co., Philadelphia, Penn.

Prof. A. N. Talbot, of the College of Engineering of the University of Illinois, received the honorary degree of Doctor of Science from the University of Pennsylvania at the 1915 commencement.

Claude A. Bulkeley, formerly consulting mechanical and electrical engineer, New York City, has become chief consulting engineer with the Canadian Domestic Engineering Co., Ltd., Montreal, Can.

H. T. Matthew has been apointed Pacific Coast representative of the Society for Electrical Development, Inc., and will act for that society in connection with the big "Electrical Prospect Week" campaign. Mr. Matthew for the past three years has represented the McGraw Publishing Co. on the Pacific Coast.

ENGINEERING AFFAIRS

The Bureau of Standards has been jointly appealed to by the Underwriters' Laboratories and the Economy Fuse & Manufacturing Co. for decision on the following question: "Has it been shown that the use of the fuses manufactured by the Economy Fuse & Manufacturing Co. results in no greater fire or accident hazard than the use of other cartridge-inclosed fuses at present listed as standard by Underwriters' Laboratories?" A public hearing will be held at the Bureau of Standards, Washington, D. C., at 10 a.m. on July 8. The Underwriters' Laboratories and the Economy company will present evidence, and any other manufacturers of cartridge-inclosed fuses, state, city and insurance inspectors are invited to submit either at the hearing or in writing any statements of facts or results of experience directly bearing on the question at issue.

BUSINESS ITEMS

K. E. Kersten has been appointed branch manager of the Boston Belting Co., with headquarters at 172 West Randolph St., Chicago, Ill.

The Home Rubber Co., Trenton, N. J., announces that J. B. Foley, son of the late Arthur R. Foley, who has been associated with the company for a number of years, will now make periodical visits to the trade formerly waited upon by his father.

Stewart M. Marshall, for many years chief engineer of the Cambria Steel Co., Johnstown, Penn., is now associated with the Southwark Foundry & Machine Co., Philadelphia, Penn., as manager of its turbine and centrifugal pump departments. Mr. Marshall will also have charge of all engineering matters relating to apparatus used in conjunction with turbines, such as blowers, electric generators, condensers, etc.

The Ingersoll-Rand Co., 11 Broadway, New York, has opened a branch office in San Francisco, Calif., at 139 Townsend St., with a view to giving closer attention to present and prospective users of Ingersoll-Rand machinery than it is possible for any agency to do. Harron, Rickard & McCone will coöperate with the company in the sale of Ingersoll-Rand machinery after the expiration of their agency contract on July 22, and H. L. Terwilliger will be district manager for the territory handled by the San Francisco and Los Angeles offices, with headquarters in San Francisco.